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MARINE BIOLOGICAL LABORATORY.

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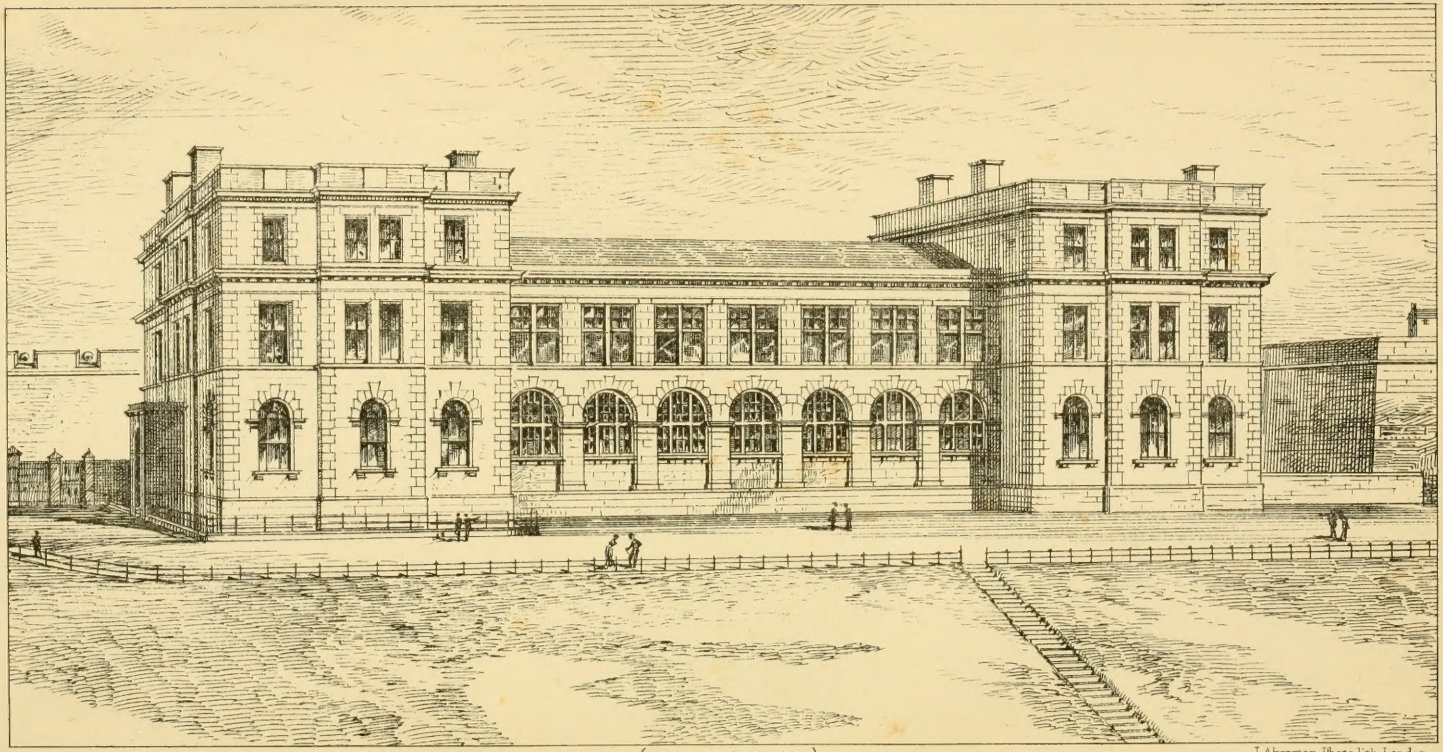

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SOUTH FRONT OF THE LABORATORY OF THE MARINE BIOLOGICAL ASSOCIATION, ON THE CITADEL HILL, PLYMOUTH.

PREFACE

TO THE

Journal of the Marine Biological Association.

The Council of the Marine Biological Association of the United Kingdom has determined to issue to its members notes and reports concerning the work of the Association in the form of a Journal, which will appear at intervals, determined by the amount of material ready for publication. It is not proposed to limit the contents of this Journal to formal reports, nor to publish in it lengthy scientific memoirs, but to include within its pages, besides the official statements of the Council, brief records of observations relating to the marine biology and fisheries of the coasts of the United Kingdom which may appear to have a definite bearing upon the work actually in progress under the auspices of the Association. With this object in view the Council of the Association invite communications from fishermen and naturalists, which may either be printed in full in this Journal or form the subject of a note.

The Journal will contain the annual and other official reports of the Council of the Association, and will form a means of communication between the Council and the members of the Association.

The first number of the Journal contains a list of the Officers, Governors, Founders, and Members of the Association, and the Annual Report of the Council for the year 1886-87. It also contains a description with plans of the Plymouth Laboratory, and an account of the Fishing In-

dustry of Plymouth, prepared by Mr. Walter Heape at the request of the Council of the Association, with the view of furnishing to naturalists information concerning the food-fishes taken off Plymouth and their mode of capture, which is necessary as a preliminary to those "accurate researches leading to an increase of our knowledge as regards the food, life-conditions, and habits of British food-fishes and molluscs," which the Association was founded to promote.

A list of the Fauna and Flora of Plymouth Sound, so far as known at the present date, *i. e.* before the Association has commenced its operations, will be published in the next number of the Journal. It will be one of the objects of the naturalists working at the Plymouth Laboratory to extend this list, and to ascertain the relations to one another and to physical conditions of the various organisms therein included, especially of those which are either themselves commercial fishes or serve as the food of such fishes.

Communications intended for the Journal should be addressed to the undersigned.

E. RAY LANKESTER,
Hon. Sec. M. B. A.,
University College, Gower Street,
London, W.C.

August, 1887.

LIST

OF

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31ST MARCH, 1887.

The names of Members deceased since their connection with the Association are printed in italics.

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	£	s.	d.	
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	£	s.	d.
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	£	s.	d.
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Carr, Rev. E. T. S., M.A., St. Catharine's College	1	1	0
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	£	s.	d.
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The History of the Foundation of the Marine Biological Association of the United Kingdom.

In the 'Times,' March 31st, 1884, appeared the following article:

Biological station, some may be inclined to think, is simply Aquarium "writ large." The two certainly do coincide to some extent; a biological station as a rule implies an aquarium, but it includes a great deal more. In the early days of public aquaria, some twenty-five years ago, and down indeed to more recent times, attempts were made to utilise these institutions for scientific purposes, and biologists hoped that great results would follow from their establishment. It was in 1860 that the late Mr. Lloyd designed an aquarium for Paris, and two years later a similar one for Hamburg. Others soon followed, both in this country and on the Continent, nearly all of them constructed on the method devised by Mr. Lloyd, and several of them under his direct superintendence. Probably the earliest on a large scale in this country was the well-known establishment at the Crystal Palace, to the management of which Mr. Lloyd succeeded on the death of Mr. J. K. Lord. Others soon followed at Brighton, Manchester, Southport, Westminster, Yarmouth, Edinburgh, Rothesay, and many other towns in this country; not to mention Vienna, Dresden, Frankfort, New York, San Francisco, Melbourne, and other places abroad, with the planning of

most of which Mr. Lloyd had something to do. At the Crystal Palace, Brighton, Birmingham, and elsewhere, efforts were made to make these aquaria serve the purposes of scientific research, and at the same time to keep them open to the public as places of entertainment and some little instruction. In some of them naturalists' rooms or laboratories were established, and experiments and observations attempted with a view to adding to our scientific knowledge of the creatures whose graceful movements the public never tire of admiring. But the great essential of all such institutions was and is that they should pay. They were regarded by shareholders and managers as simply forming part of their big show, not to be compared in attractiveness to nigger minstrels, Lulu, or a Chinese juggler, but still useful as a bait to catch certain classes of the public. Naturally the views and aims of the management and of the presiding naturalist clashed, and the latter had either to adapt himself to the leading purpose of the establishment or to resign. At all events, it finally became evident to biologists that science could expect little help from the ordinary aquarium, which was no more than a handmaid to the amusement of the public. To accomplish her noble purposes she must be mistress. We believe the French were the first to recognise this important truth, and to establish a station solely for the purpose of investigating the habits, organisation, and surroundings of the denizens of the ocean. Now they have quite a number of such stations in operation—as, for instance, at Roscoff, Concarneau, Villefranche, and Cette. The Austrian Government maintains a similar station at Trieste, while in America the John Hopkins University has one at Beaufort, and Professor Alexander Agassiz another at Newport. The Dutch have for several years had a travelling laboratory erected during the summer months at different parts of their coasts. But undoubtedly the finest institution of the kind is that founded ten years ago at Naples by a German biologist, Dr. Anton Dohrn, to the work of which we have at various times referred in our columns. The Naples station is indeed an international institution, for although

it is subsidized to the extent of £1500 a year by the German Government, its workers and much of the rest of its income, which in all amounts to about £5000 a year, come from all parts of the world. The University of Cambridge maintains a table for one of its students, as does also the British Association. America has always one or two investigators working under Dr. Dohrn, while various European countries have their representatives. Not only has the Naples station its tanks and its laboratories, but it maintains steam launches and boats of various kinds, diving apparatus for investigating the sea bottom, dredges and trawlers, sailors and fishermen trained as collectors, and issues regularly a series of handsome 'Transactions,' comparable to the publications of our "Challenger" expedition. The advances made in the special department of biology connected with fishes since the establishment of the Naples' station has been immense, and has had besides important bearings on other departments of the same branch of science. In this country no regular station of the kind has existed until within the last few months, when, under the auspices of the Scottish Meteorological Society, one has been established in an old quarry at Granton on the Firth of Forth, near Edinburgh. Already the naturalists at Granton have done good work in investigating the habits of the economical fishes, and especially the herring, and some of the results of their work were described to the Royal Society last Thursday by Professor Cossar Ewart, of Edinburgh. For several years the British Association has had a committee to superintend the working of a Scottish zoological station; but the station has been peripatetic and temporary, maintained only during the summer months at different parts of the Scottish coast; nevertheless it has done excellent work. British naturalists have been long convinced that both from a scientific and economical point of view it is high time that a permanent station on the model of that of Naples were established at some suitable point on the coast of England. The success of the recent Fisheries Exhibition has encouraged this prevalent feeling, and has led our leading scientific men to

take definite steps to place England in this respect on a level with other countries. As we have already announced, a meeting will be held to-day in the rooms of the Royal Society to carry out this object. This will be accomplished by founding a society having for its purpose "the establishment and maintenance of a well-equipped Laboratory at a suitable point on the English coast, similar to, if not quite so extensive as, Dr. Dohrn's zoological station at Naples." Among the supporters of the movement are the most influential naturalists in the kingdom. Professor Huxley, P.R.S., will preside, and others who have promised to be present are Professor Flower, Professor Moseley, Sir Lyon Playfair, Sir John Lubbock, Professor Michael Foster, Professor Ray Lankester, Dr. Günther, Dr. W. B. Carpenter, Mr. Gwyn Jeffreys, Dr. P. L. Sclater, and Mr. W. S. Caine, M.P. (one of the Commission on Trawling). With such powerful support it seems to us that the object in view is sure to be accomplished. Both from an economical and scientific standpoint the utility, indeed the necessity, of such an establishment appears obvious. Already the Granton station has done good service to the Scottish fishermen; but even if no ends were to be served by such a station except those of pure science, these in our estimation are so important as to justify the movement which has secured such influential support. The utility in its highest, and even in its lowest, sense of encouraging scientific research may now be taken as recognised in all civilized countries. All the most valuable "practical" discoveries have been made by men who were not seeking for them, but whose sole aim was to satisfy a noble inquisitiveness. Our Government recognises the necessity of encouraging science in its magnificent establishments at Bloomsbury and South Kensington, and in its subsidy of £5000 a year to the Royal Society for purposes of research; and none but chronic grumblers would grudge another £1000 a year to the support of the proposed station, which indeed may be regarded as an almost indispensable adjunct to the Natural History Department at South Kensington. The necessity for research in this direction was recognised at

the final meeting of the Fisheries Exhibition Commissioners, when they voted £3000 for the formation of a Royal Fisheries Society. They have still £2000 in reserve, and as the exhibition was as much scientific as economic it seems only natural that part of this should find its way to help in the construction of a station whose sole purpose would be the investigation of the habits and organisation of the fishes of our British waters. On every side we are told that something must be done for the improvement of our fisheries; science has done so much in recent years to improve every other department of industry that, in our opinion, it is quite worth while asking her to do something for a department which is of growing economical importance. She must, however, be allowed to do it in her own way, and the names of those who are to take part in the meeting of to-day are a sufficient guarantee that any funds with which the future society will be entrusted will not be abused. The movement is one which certainly deserves public support and the countenance of the Government.

It is intended to erect the proposed Laboratory at a point as rich as possible in respect of its marine Fauna, and at the same time in proximity to important fishing grounds. No locality, we are told, has yet been decided, but both Torquay and Weymouth have been suggested as presenting the desired combination. There can be little doubt that Monday's meeting will be the first step to the accomplishment of the great object in view, in the near future.

The meeting was duly held in the afternoon of March 31st, 1884, in the Rooms of the Royal Society, and the report of it, which has been reprinted in the following pages, was largely circulated.

Report of the Foundation Meeting of the Marine Biological Association.

Professor Huxley, President of the Royal Society, who presided, in opening the proceedings, said: A great number of gentlemen who would have been glad to be present in support of the object of the meeting have been unable to appear. The Right Hon. Joseph Chamberlain, M.P., has written a letter cordially approving of the objects of the Society, and hoping it will be strongly supported. Mr. Burdett-Coutts, who has taken a very great interest in the Fisheries Exhibition, expresses his warm approval of the scheme, and offers a handsome subscription. Mr. Duff, M.P., who is greatly interested in sea fisheries, and the Marquis of Hamilton, one of the most active members of the Fisheries Exhibition Commission, also write to express their regret at being detained by business so that they cannot be here to-day. There are also letters from Lord Derby, from Sir Thomas Dakin (Prime Warden of the Fishmongers' Company), and from Dr. Dohrn, of Naples, who has carried out a similar scheme to that which this meeting has in view, viz. the celebrated Zoological Station of Naples. Dr. Dohrn speaks of the project with warm approval. Admiral Sir Erasmus Ommaney and Dr. Acland, of Oxford, write to express their regret at being absent, the movement being one in which they take great interest. In supporting what I understand to be the object of the proposal before us, which I may say is not in my hands, but chiefly in those of Professor Lankester, I simply express the interest in it which biologists feel, and the desire of the Royal Society to foster the new undertaking, which appears to promise well for the good of science. The establishment of laboratories for observation of the Fauna and Flora of the sea has now taken place in most civilized

countries, and is, in fact, a necessary consequence of the great change which has taken place in the whole of the aims of biological science. The study of development, commenced in a serious way half a century ago, and the further progress and ramifications of that line of inquiry, which has been extended to the mode of existence of all living things by Mr. Darwin, has caused a complete change in the methods of biological science, and consequently, in the methods by which biological investigation is pursued. In order to understand the living being now, it is no longer sufficient to be acquainted with its outside, as in the days of our forefathers, or even with its inside, so far as obvious anatomy is concerned, as was the case with the immediately preceding generation. We now, in order to understand the being, relations, and affinities of an animal, have to go back through the whole course of existence beyond, in order to trace out the successive stages of development from the egg; and this can now be done with a precision and accuracy which in my young days we had no conception of. But though from a purely scientific point of view this is one great reason for establishing laboratories of the kind now proposed, a more directly practical reason exists. We possess great fisheries, which are more or less regulated by legislation, and which are of great importance to very large masses of the population. Hitherto—certainly within the last thirty years—such regulations have been made in an almost entirely haphazard manner, because of the want of knowledge of the habits, the mode of life, the mode of production, &c., of the animals which are economically useful. At the present time it is within my knowledge that a great deal of vehement opposition to particular modes of fishing has been due to the absolute ignorance of the fishing population of some of the primary facts of the mode of life and reproduction of our food fishes; and it is of essential importance that those who wish to regulate fisheries should rest their arguments and their reasonings upon a definite and solid foundation, and upon a complete knowledge and sound observation of the mode of life and development, and so forth, of the animals which constitute the staple of our fishing

wealth. These are the two objects which the proposed Society has in view. I wish to say very emphatically that in my opinion there is no possibility of any rivalry or conflict of aims between the Society which is now to be founded, and the one whose formation was announced by H.R.H. the Prince of Wales, at the meeting of the Committee of the International Fisheries Exhibition the other day, the object of which was to be simply practical, in the ordinary sense of the word, and related to the collection of statistics, the condition of fishermen, and so on. An important part of the functions of the Royal Fisheries Society would be an inquiry into the habits and modes of life of food fishes, and I sincerely trust that when both societies are established, our Biological Society, so far from being a hindrance or rival to the larger society, will be only too ready to take up that particular part of the work germane to its purpose, viz. the habits and mode of life of the food fishes, so that the two societies will be able to work in harmony towards one common end.

The Chairman then called upon the Duke of Argyll to move the first resolution as follows :—"That in the opinion of this meeting there is an urgent want of one or more laboratories on the British coast similiar to those existing in France, Austria, and America, where accurate researches may be carried on leading to the improvement of zoological and botanical science, and to an increase of our knowledge as regards the food, life, conditions, and habits of British food fishes, and molluscs in particular, and the animal and vegetable resources of the sea in general."

The Duke of Argyll said,—I consider it a great honour to have the privilege of moving this resolution. I suppose that the fact of our being called together to-day to form a society implies a discovery on the part of those who have taken the lead in the matter that the work is not likely to be taken out of their hands. I mean out of the hands of voluntary societies by the Government. I am afraid that the British Government has always stood behind other Governments, whether monarchical or republican, in the promotion of scientific discovery. In America, I believe,

the Government takes a more active and direct part in the promotion of biological and other scientific discovery. At the same time, on the whole, perhaps we have not much reason to complain, for in recent years the expenditure of the English Government on purely scientific objects has been very large, and I have been long enough a member of Governments to know that every year, when the Chancellor of the Exchequer comes to make up his Budget, there is considerable pressure brought to bear upon him in the matter of reduction of taxation, and of the growing burden of the Civil Service estimates, and therefore, though after a time we may hope for the assistance of the Government, yet it is hardly to be expected that the Government will take this enterprise out of our hands at once. At the close of the last Fisheries Exhibition I had the pleasure of being present at a conference where a hope was expressed that some portion of the surplus—then expected to be a large one—from the Fisheries Exhibition might possibly be applied to this purpose. You have all seen, from a speech of the Prince of Wales, that a very large part of the latter fund is likely to be applied to another purpose, which is no doubt most legitimate, and which I admit to be excellent, namely, the support of the widows and orphans of those fishermen who lose their lives on our coasts. Therefore we cannot look to this source for funds. Now, coming to the terms of the resolution, and to the objects which have been explained by Professor Huxley, I notice that there are mixed together in this resolution the desire to contribute to the economic uses of science, and to the purposes of pure biological research. I feel some doubt whether, on the mere ground of economical application, the Society will be necessary. Economic interests can take care of themselves. There are already many agencies in this country through which most of the facts can be ascertained as regards our food fishes. Some have been already ascertained by our distinguished President (Professor Huxley), and a paper has been contributed lately to the Royal Society by Professor Ewart in relation to one of the most important questions connected with the economics of food fishes, viz.

the spawning of the herring. It is quite true that a great many of the objections which have been made to the operation of certain modes of fishing have been entirely due to mistaken ideas as to natural history, as, for instance, the supposed loss caused to the spawn of the herring by the system of fishing known as trawling. A good number of my own people have been for centuries almost entirely dependent upon the herring, and, strange to say, within the last twenty years the shoal of herring have almost deserted the upper portion of Loch Fyne, where there had been for generations most lucrative fishing. The poor fishermen hold that this desertion is owing to the employment of a special mode of fishing, but it really arises from causes which no man knows, as yet. These poor people believe that this decline in the yield of the herring is due to the new mode of fishing introduced twenty-five years ago, and which is locally termed "trawling," though totally different from what is termed trawling in England. It is really fishing by the use of a seine net. The fishermen think that trawling breaks the shoals, scaring the herring and intercepting their passage to Loch Fyne. Another objection is, that a seine net drags up quantities of spawn, but this is found to be impossible, for the spawn shed on a stone adheres firmly to it, and the action of the trawl net cannot possibly disturb the spawn, which has been discovered clearly to be deposited by the female fish so as all to adhere to the bottom.

I am strongly of opinion that, in starting our Society, we should in the main look to the interests of biology as a science. For my own part, I can sincerely say that I came here to move this resolution as a means of promoting biological research. I look upon biology as by far the highest of all the branches of natural science. I know that there are some persons who will not accept that proposition. Some prefer the more exact sciences, in which they can obtain results supported by positive demonstration, and capable of methodical proof. There are many persons who decry researches in biology on the ground that they are less certain and exact, and that they are accompanied

very often by hypotheses not capable of demonstration. I may say that I have no sympathy with that feeling. You cannot in the pursuit of science get rid of hypotheses. They are absolute necessities and instruments of research. The experiments conducted by our new Society will go far to prove or disprove many of the hypotheses which are held in respect to the origin and development of life. I remember thirty years ago reading in a very remarkable book, which made a great sensation at the time,—a book written by Hugh Miller, a man of considerable genius, not only on account of his command of literary style, but also on account of that which Professor Tyndall has so much emphasised, "the scientific use of the imagination;" I remember, I say, seeing in this book, which was published some six or ten years before Darwin's 'Origin of Species,' and when the author had to deal with the theory of descent in the older forms in which it appears in the 'Vestiges of Creation,' that the author ventured to suggest that the flat fishes showed every indication of being a degenerate branch of the round fishes. I thought at the time that that was one of the wildest theories that could be conceived. It was connected with the recently revived theory of possible degradation from a higher organization. It now turns out from various observations in aquaria in America, Sweden, and elsewhere, that this strange imagination was perfectly correct, and that there is good evidence for the belief that the flat fishes have been derived from the round fishes. The young of the common flounder, I believe, is born or hatched in the round condition. This is a remarkable indication of how pursuits such as are contemplated by this Society may be of the greatest assistance to scientific men in regard to the history of life.

Granting that biology is one of the very highest branches of natural science, I think I am right in saying that the sea is the area in which and out of which we can best get at some of the secrets of organic life. The sea, I may say, is more rich in the variety of forms of life than the land. I sometimes use the dredge from my yacht, and I never empty the contents of the dredge without standing in

astonishment at the enormous fertility and variety of life brought to the service—fishes, crustacea, and zoophytes, of every sort, and the lowest forms of sponge-life are brought up at haphazard, with immense numbers of molluscs and cuttle-fishes upon almost every occasion. It is impossible in these circumstances not to be struck with the immense fertility of the sea. There are special circumstances affecting marine life which make it an especially valuable field for observation. Many specimens are almost crystalline in transparency, and one can see the insides of the animals without wounding their outsides; there is thus this great advantage, that in the study of biology we get rid of those painful discussions which have been raised in regard to vivisection, because, quick as the sympathies of modern society are with every form of suffering, it has not yet occurred to anyone to object to the vivisection of a jelly fish. I hope and believe that by the operations of a society like that which it is proposed to establish some of the most important questions of physiology may be settled without vivisection.

The Right Hon. Sir Lyon Playfair, K.C.B., seconded the resolution. He said,—The motion is one which commands my hearty sympathy. It is an extraordinary fact that while other nations having far less interest in the sea than the United Kingdom, have established, either by private generosity or by public aid, laboratories for the study of marine life, England has not made even a beginning in this important work. The need for such laboratories is recognised, and an effort has lately been made in Scotland to found one, which already promises success. Though the promise of practical utility from such laboratories is very great, that is not the first or the only thing to be considered. Laboratories of this kind, in which the habits of all kinds of marine life should be studied, ought primarily to be established—not with a view to practical uses, but with the main purpose of advancing science for its own sake. Science so studied rewards a nation a thousandfold in the most unexpected practical applications; but without science there are no applications. It is only when

the streams of science are full that their overflowing produces fertility to the land upon their banks. The marine laboratories, such as those we wish to see founded, should not primarily be established to bring an increased supply of fish to our frying-pans and fish-kettles. Their main purpose should be to examine the development and habits of all forms of marine life, so as to give the biologist a better insight into the laws which govern their existence. I would take as an example the laboratory of my friend Mr. Agassiz, at Newport, in Rhode Island. He is a man of ample fortune, and spends it nobly in the advancement of science. His laboratory for studying marine biology is purely a scientific one, and the idea of practical utility has probably never crossed his brain. Yet it is one of the invariable consequences of the fulness of science that it does reward the nation or individual who prosecutes it in a disinterested spirit with many material advantages. Perhaps you will allow me to draw an illustration from my frequent visits to America of how science can, and does, repay the study of marine life. The American Government gives much support to a Commission of Fisheries, under the presidency of Professor Baird. The Commission's object in this case is practical, though the practical results are attained by scientific methods and scientific study. These have already repaid the State a thousandfold its wise expenditure. I have only time to give two instances. The cod is a most important fish for the coast of North America; but the cod loves the colder coasts of British America more than the warmer shores of the United States. The grey cod used to be only a winter fish in the bays of the States; for in summer it goes to Newfoundland, to get the cooler waters of the Arctic stream. Nothing would appear more hopeless than to alter the habits of fish; but science is never discouraged as long as she works within natural laws, and even this has been accomplished. The cod is a most prolific fish, as a full-sized one weighing 99 lbs. has as many as 9,000,000 eggs. The artificial incubation of these is now so well understood in the hatching ponds of the States, that it is carried on with perfect success. Let us

assume that only fifty full cod are used for artificial incubation, then the young produced would be 450 millions. Now, the whole catch of cod by human agencies on the coasts of North America is only 150 millions, so that fifty cod, so treated, would more than suffice to produce that number. Man, however, is an insignificant factor in the destruction of fish, for they have many enemies even of their own kind to encounter. The blue fish, which abounds on the American coasts, is a cruel tiger of the sea. It does not swallow other fish for food, but it snaps a mouthful out of one fish and then attacks another in a like way, eating, it is believed, its own weight of fish for food daily. This, and the other enemies to the young cod, interfered greatly with the labours of the artificial incubation; but persistence has been rewarded with success. The cod thus artificially hatched are attached to the place of their birth, and do not seem to know their way to the coasts of Newfoundland; and so they keep to the shores of the States, and are now freely caught in summer, being called by the fishermen "Commission cod." If I do not tire you, let me give one other instance. The American shad is a fish greatly esteemed by our Transatlantic kin. It only spawns on the sea coasts at a temperature within a few degrees of 60° F. If cold rains lower the temperature to 55°, or if hot weather raises it to 65°, the shad run out to sea to spawn. Formerly, after a cold or hot spell of this kind, the fishermen knew that in the fourth year after it there would be a famine of shad, but this occurs no longer; for the Commission vessels now follow the shad to sea, secure their eggs, and hatch them artificially. So no famine is now known. Although I would have preferred to support the motion for marine laboratories more on the ground of their importance to abstract science than to show those who look to practical applications the enormous benefits which come from a study of the habits of marine life, yet had I time, I could refer to the important applications made recently in the United States on the subject of oyster cultivation, and to the valuable and interesting paper of Professor Cossar Ewart on the spawning of herring in Scotland—a subject familiar

to the Chairman and less familiar to myself, though we both served in a Commission on the herring fishery. Those who love science for its own sake will largely promote it by aiding to establish marine laboratories in this country, and those who know science only through its useful applications to man may feel fully confident that any encouragement which they give to this undertaking will be repaid a hundredfold in proximate, if not in immediate, benefits to the human race.

The Earl of Dalhousie, in supporting the resolution, said that he did so especially in relation to the practical part of the question. Professor Huxley had referred to the wonderful hypotheses of the fishermen on the British coast in regard to the habits and movements of fish. He (the speaker) had been Chairman of a Commission appointed to inquire into certain difficulties between fishermen who used nets and lines, and those who used trawls. He informed himself, as far as he could, of all that was practically known in regard to the fish. He devoured a large number of blue-books, &c., and was sorry to say that ignorance with regard to the habits of the fish appeared to be by no means confined to the poor fishermen of the coast. The complaint was, that all along the coast the fish have deserted the inshore districts, and gone to sea—and nobody knew why. If the Americans had been able to bring the cod so far, it ought to be in the power of the Society now about to be formed to devise means of bringing the fish inshore after they had gone out to sea. As a testimony to the great importance which was attached to the foundation of the proposed Society, he might mention that since he had entered this room he had seen present every member of the Government Commission on Trawling, of which he had spoken.

Professor Flower, F.R.S., P.Z.S., Director of the British Museum (Natural History), also supported the resolution. He quite agreed with the Duke of Argyll that they could hardly complain of the Government when they saw the magnificent manner in which our national collections of zoology were housed. But before they could exhibit their

specimens they must catch them, and he ventured, in addition to the admirable arguments of the mover and seconder, to suggest that these laboratories would be the means of supplying not only our great national museums but all the local museums throughout the British Islands with specimens which would bring home to all the population in the country a knowledge of the wonderful forms of sea life. It was quite impossible at the present time to get a really systematic collection of specimens. This alone would be a good reason for establishing such laboratories as the new Society contemplated.

Dr. W. B. Carpenter, C.B., F.R.S., then moved :—" That it is desirable to found a Society, having for its object the establishment and maintenance of at least one such Laboratory at a suitable point on the coast, the resources of the Laboratory, its boats, fishermen, working rooms, &c., being open to the use of all naturalists under regulations hereafter to be determined." He had for a great many years taken a great interest in this particular subject, and would like to supplement what Sir Lyon Playfair had stated in regard to the American work of this kind, by reading the programme laid down in the very first report which Professor Spencer Baird, who had the organization of this Commission in the year 1874, had issued :—

Extract from the First Report of the United States Commission of Fish and Fisheries (1873), pp. xiii, xviii.

> " The objects of the investigation, as authorized by Congress, were, *first*, to determine the facts as to the alleged decrease of the food fishes; *secondly*, if such a decrease be capable of substantiation, to ascertain the causes of the same ; *thirdly*, to suggest methods for the restoration of the supply ; and *fourthly*, to work out the problems connected with the physical characters of the seas adjacent to the fishing localities, and the natural history of the inhabitants of the waters, whether vertebrate or invertebrate, and the associated vegetable life.
>
> " The history of the fishes themselves would not

be complete without a thorough knowledge of their associates in the sea, especially such as prey upon them, or in turn constitute their food.

"Furthermore, it was thought likely that peculiarities in the temperature of the water at different depths, its chemical constitution, the percentage of carbonic acid and of ordinary air, its currents, &c., might all bear an important part in the general sum of influences upon the fisheries; and the inquiry, therefore, ultimately resolved itself into an investigation of the chemical and physical characters of the water, and of the natural history of its inhabitants, whether animal or vegetable. It was considered expedient to omit nothing, however trivial or obscure, that might tend to throw light upon the subject of inquiry; as without such thorough knowledge it would be impossible to determine with precision the causes affecting the abundance of animal life in the sea, and the methods of regulating it."

Turning to the scientific object of these inquiries, Dr. Carpenter remarked that he recollected the very beginning, he might almost say, of the modern mode of the investigation of development. He could remember the sensation produced among naturalists by the publication of the researches of Vaughan Thomson, a retired army surgeon living at Cork, which first taught them something of the development of crustacean life, which showed them what had been regarded as independent animals—the Zoœa—were really the young of the common crab, and who pointed out that still more remarkable fact, that the barnacles and sea-acorns were really modified forms of crustacea. These opinions were all pooh-poohed, and papers were published by the Royal Society to show that Mr. Thomson was all wrong, but yet his researches proved perfectly correct. He remembered hearing while at Edinburgh nearly fifty years ago, that Sir John Dalyell, a man of property and of scientific habit of mind, was engaged in biological investigations. Sir John Dalyell got information from all the fishermen round Scotland, and made most wonderful observations. His extraordinary discoveries were not believed by anybody. They related to the development of Medusæ from

polyps. These researches were not published until after their substantiation by foreign naturalists, though they had been discovered long before by Sir John ; and so he might go on to show how large a proportion of the valuable work which had given them new ideas of marine animal life had been inaugurated in this country. He would especially refer to an incident which took place at the first meeting of the British Association at Southampton, to which Edward Forbes brought an *Amphioxus* which he described in his inimitably humorous way, pointing out how it was a vertebrate animal without a vertebral column, how it belonged to the red-blooded order and had white blood, and how its pharynx was the pharynx of an Ascidian. They all now looked upon the *Amphioxus* as the sole survivor of the marvellous group which formed the link between the Vertebrata and the Invertebrata. These were the studies which formed the life-blood of biological science, and considering what had been done in this country previously it would now be shameful if we were to allow ourselves to fall behind in these inquiries. He knew Professor Agassiz' laboratory at Newport and all the admirable laboratories sustained by the John Hopkins University of Baltimore, and by the biological station at Naples and other places, and in order to persuade the Government that such things as these were really of national importance and deserving of national encouragement, it was for all interested in biological inquiry to do their very utmost to sustain an organization which would show what even one station well worked could do.

Sir John Lubbock, Bart., F.R.S., was glad to second the resolution as President of the Linnean Society and as a Trustee of the British Museum. A great deal more biological work might be accomplished with some organized assistance, such as that proposed in the foundation of a well-equipped Laboratory. There were as good fish in the sea as ever came out of it, and he thought there were many interesting and good ones, from a scientific point of view, that had never come out of it yet. He trusted that the inauguration of this Society might be the means of supply-

ing many interesting contributions to the British Museum, and also to the Royal, the Linnean, and other societies. The proposal was also of great practical importance, and he hardly knew whether the results were likely to be of greater utility from a scientific or practical point of view.

Dr. Albert Günther, F.R.S., Keeper of the Zoological Collections of the British Museum (Natural History), had spoken to many friends, both scientific and non-scientific, and had generally met with a great desire to assist an undertaking like the present one, which promised such great benefits for science, and such practical advantages for the people. It was but human that most of them desired to have the idea taken up by a society in the management of which they might have a voice. In the successful management of the proposed zoological observatories a good many different qualifications would be required. It was not a zoological station alone, but a biological one, which it was proposed to establish, and therefore for the interests of botany as well as of zoology. A good deal of technical knowledge of dredging, &c., would be required. All those qualifications could in no way be better combined than on such a basis as was promised by the council of a representative society, to which men of various qualifications would be elected. Before he came to that meeting he did not feel quite sure whether the proposal would meet with such general approval as had been the case. He had now no doubt about the success of the movement. It was much better to establish these laboratories by means of a society than by the isolated enterprise of a few individuals.

In the absence of the Lord Mayor, who had expressed his intention of being present, but was detained by a meeting in the City, Sir Joseph Hooker, K.C.S.I., F.R.S., moved :—"That this meeting does hereby agree to constitute itself such a Society under the title of 'The Society for the Biological Investigation of the Coasts of the United Kingdom.'" This was, he said, an effort which would have the hearty appreciation and strong support of the scientific bodies of the country. It was an important fact that the British coast was the richest area in the world for seaweeds.

There was no country in the world which had contributed so much to the knowledge of algæ as England. He thought there were no scientific bodies who would not take the liveliest interest in the efforts of the new Society, and that its foundation was full of promise for the future of biology.

Professor Moseley, F.R.S., observed that it was only by means of a regular station, at which systematic work could be carried out continuously, that any progress could be made in the investigation of the conditions of our coast. The work already done had been done in an unconnected way. The difficulty of investigating some of our commonest animals would be understood when he mentioned that a scientific friend of his for many years had wished to work out the development of the common limpet, of which as yet nothing was known. This animal was one of the most important of the Mollusca, both scientifically and commercially. His friend had been to the coast at various seasons to get the eggs and watch their development, but had failed, and up to this day this most important piece of work had never been accomplished. Under the new Society they would, during the very first year of the continuous working of a laboratory, get to know pretty thoroughly the development of the limpet. He did not think that any investigation not of a strictly scientific character was of much value with regard to practical results. It was only by the most thorough scientific work that we should ever arrive at the increasing of our supplies of oysters and lobsters. This year most interesting results have been obtained in the United States with regard to the oyster. With regard to the furtherance of biological science generally, the more they understood animal life the more they found that all animals had gone through a littoral phase. Animals may have originated in the open sea, but all animals seem to have passed through a littoral stage. From the littoral condition of animals are derived all the animals of the deep sea. All terrestrial animals have come from the shores. Even in man himself there were structures in the embryonic state only to be explained on the

theory that his ancestors had lived in the waters of the seashore.

Dr. Sorby, F.R.S., said that some years ago he was anxious to assist in such an institution as that now proposed, and also to bear some of the cost. He hoped now to render some assistance to the new Society, seeing that he lived half the year in his yacht, carrying on investigations, some of which he intended soon to communicate to the Royal Society. He was desirous of taking an active part in the work of the Society.

Sir William Bowman, F.R.S., moved:—"That the following gentlemen be requested to act as a provisional council, and report to an adjourned meeting, to be held on Friday, May 30th, as to the constitution and organization of the Society, and other matters, and in the meantime have power to admit suitable persons to the membership of the Society; further, that Professor Lankester be asked to act as Secretary, and Mr. Frank Crisp as Treasurer *ad interim*." Those named were the Duke of Argyll, the Earl of Dalhousie, Lord Arthur Russell, the Lord Mayor, the Prime Warden of the Fishmongers' Company, the President of the Royal Society (Professor Huxley), the Presidents of the Linnean (Sir John Lubbock), Zoological (Professor Flower), and Royal Microscopical Societies (Dr. Dallinger), Dr. W. B. Carpenter, C.B., F.R.S., Mr. W. S. Caine, M.P., Mr. Frank Crisp, V.P. and Treas. L.S., and Sec. R.M.S., Mr. Thomas Christy, F.L.S., Mr. Thiselton Dyer, F.R.S., C.M.G., Mr. John Evans (Treasurer of the Royal Society), Dr. Albert Günther, F.R.S., Sir Joseph Hooker, K.C.S.I., Professor Michael Foster (Secretary of the Royal Society), Professor Ray Lankester, F.R.S., Professor Ewart, F.R.S.E., Professor Milnes Marshall, Professor Moseley, F.R.S., Mr. John Murray, F.R.S.E., the Rev. Dr. Norman, F.L.S., Sir Lyon Playfair, K.C.B., Mr. George J. Romanes, F.R.S., Professor Burdon Sanderson, F.R.S., Dr. Sclater, F.R.S., Mr. Adam Sedgwick, Mr. Percy Sladen, F.L.S., Dr. H. C. Sorby, F.R.S., and Mr. Charles Stewart, F.L.S.

Mr. George J. Romanes, F.R.S., seconded the resolution,

saying that he thought he should not be able to express his view more strongly than by saying that in his opinion the proceedings of that afternoon had been taken many years too late. When we remembered our great maritime power, that our coasts extended for tens of thousands of miles, and in all latitudes, and that England was mistress of the seas, it seemed to him nothing short of a national disgrace that we alone should have been so long content with having hitherto done little or nothing in the way of systematic investigation of the marine zoology of our own shores. But if such had been our amazing apathy in the past, the best they could do was to retrieve the error by striking while the iron was hot, viz. by constituting themselves a Society, with an executive committee. The list of names was one of very great force, and it would be difficult to add to its force. Professor Flower had said that each speaker should contribute one point to the discussion. He (Mr. Romanes) should like to observe that there was one function of the proposed Laboratory which had not received the attention it appeared to him to deserve; he meant the investigation of invertebrate physiology. In the invertebrate forms of life we saw life in its simplest shape, and in the shape which best admitted of observation and experiment, with the view of throwing light upon most of the great questions relating to the processes of life. Where were they to look for the material for this investigation? Unquestionably to the sea, which was the great magazine of such life. He therefore looked forward with some confidence to the time when it would certainly not be considered the least important function of the newly-formed Society to investigate the physiology of the invertebrate forms of life.

Professor Lankester moved a vote of thanks to Professor Huxley for taking the chair, which was seconded by Sir Joseph Fayrer. Before putting the vote, Professor Lankester mentioned that it was hoped that they might raise a fund of from £6000 to £10,000 for the purpose of starting one Laboratory, and it would now be possible for individuals who took an interest in the proceedings of the

Society, to send to the Treasurer, Mr. Frank Crisp, cheques for £100 or £1000 to start the fund. If those who believed in the utility of the Society, and its projected Laboratory, were prepared to subscribe generously to the Laboratory Fund, the anticipations of those who had spoken so hopefully of the work taken up by the Society would be speedily realised.

At the first Annual Meeting in June, 1885, of the Association thus founded, subscriptions to the amount of £8000 were announced. At the second Annual Meeting in June, 1886, the subscriptions amounted to nearly £15,000, and at the third Annual Meeting in June, 1887, the approaching completion of the Laboratory on the Citadel Hill at Plymouth, and the commencement of active work, formed the subjects of the Council's report.

Report of the Council of the Marine Biological Association for the year 1886-87.

PRESENTED AT THE THIRD ANNUAL GENERAL MEETING OF THE ASSOCIATION, HELD ON JUNE 24TH, 1887, IN THE ROOMS OF THE LINNEAN SOCIETY, BURLINGTON HOUSE, LONDON.

I. The Council has met during the past year six times. Its attention has been chiefly occupied with the superintendence of the building and the fitting of the Laboratory at Plymouth, and with making arrangements for the future work of the Association in connection with the Laboratory. A Committee of the Council have been actively engaged in preparing plans for the fittings of the building, and the plans thus carefully devised have been adopted by the Council. It is expected that the Laboratory will be ready for partial occupation in the present summer, but the tanks and circulation of sea water cannot be completed for some months to come. The Council has every reason to express satisfaction with the progress which has been made with the building, and with the attention given to its construction by Mr. Inglis, of Plymouth, the engineer to the Association.

II. The Council has determined to employ a skilled Naturalist at Plymouth (in addition to the Resident Superintendent), to carry on investigations into the natural history of British Marine Food-fishes, under the direction of the Council. It has been determined to assign a salary of £250 a year to the Naturalist so employed, and an advertisement has been printed in 'Nature' and the 'Athenæum' inviting applications for the post. The applications are to be sent in before or on June 30th, and the Council will make the appointment in July.

III. On the application of the Council the Government Grant Committee of the Royal Society has placed a sum of

£250 at the disposal of a committee, consisting of the President and Secretary of the Association, the Chairman of the Council, and Mr. Adam Sedgwick, F.R.S., for "the investigation of the Fauna and Flora of Plymouth Sound at the Plymouth Laboratory." The committee who have the disposal of this grant have not yet made arrangements for its expenditure. For their purposes the Committee will have the use of the appliances of the Laboratory of the Association as soon as they are sufficiently advanced to be of service, whilst the researches conducted under the auspices of the Committee will be of essential value to the Association in its endeavours to carry out the purposes of its foundation, viz.: "to promote accurate researches leading to the improvement of Zoological and Botanical Science, and to an increase of our knowledge as regards the food, life-conditions, and habits of British Food-fishes and Molluscs."

IV. The Council has to report further substantial additions to the funds of the Association from the Mercers' Company, and from the Skinners' Company; also from the Cambridge Committee, and from several private individuals. The Treasurer's report shows that during the year there was received from Donations and Subscriptions £4240 2*s*. 6*d*., and from Interest on Investments £224 9*s*., whilst there was paid, to the Contractors £2660, for Salaries £266 4*s*. 6*d*., and for Sundries £121 5*s*. 7*d*. The Donations assured, but not yet received from all sources (exclusive of the annual grant of £500 a year for five years, to be paid by Her Majesty's Government during the years 1888—92) amount to £3800, a total estimated balance of nearly £12,000.

V. The Council has accepted, in accordance with Bye-law 17, the donations of £500 from committees acting on behalf of the Universities of Oxford and of Cambridge respectively. In pursuance of the provisions of that Bye-law the University of Oxford has nominated Dr. J. Burdon Sanderson, F.R.S., Professor of Physiology in the University, as a Member of Council of the Association. The University of Cambridge has similarly notified the nomination of Dr. Michael Foster, F.R.S., Professor of Physiology in the University, as a Member of Council.

VI. In order to prepare the way for the further work of the Association at Plymouth, Mr. Walter Heape, M.A., the Resident Superintendent of the Laboratory of the Association, has at the request of the Council drawn up two reports, entitled respectively 'Notes on the Fishing Industry of Plymouth,' and 'Preliminary List of the Fauna and Flora of Plymouth Sound.' Mr. Heape has also, acting under the direction of the Council, hired a trawler and commenced an inquiry into the natural history of the common sole, which will be prosecuted with increased vigour as soon as the Laboratory arrangements are complete. Some experiments on the cultivation of the sole in a "mulletry," or fish-pond open to the tidal-water, were also commenced by Mr. Heape in the month of April, but are necessarily not yet in a condition for report.

VII. The Council has decided to issue to Members of the Association, in the form of a Journal, to be published at intervals, the Annual Reports of the Council, together with such papers as those prepared by Mr. Heape, and other information which the Council desires to place in the hands of the Members of the Association. It is thought that such a Journal may serve not only for the circulation of the official publications of the Council, but also as a means of inquiry and exchange of information amongst those who are interested in Marine Biology in its relation to the Sea Fisheries of the United Kingdom. The first number of the Journal will contain the present Report, a list of the Officers, Council, and Members of the Association, Mr. Heape's 'Notes on the Fishing Industry of Plymouth,' and an illustrated description of the Laboratory on the Citadel Hill, now approaching its completion.

VIII. One of the most important appliances which the Marine Biological Association must possess in its Plymouth Laboratory is a first-rate Biological Library. Before making purchases the Council have decided to ask the Members and friends of the Association to assist in the formation of this Library by gifts of books. It is probable that many who will read the present Report have in their possession duplicate copies of illustrated works on the British Fauna and

Flora, and of recent or classical monographs on important groups of animals and plants, as well as of works on fish and fisheries in general. Those who do not possess duplicates of such works may nevertheless be able to lighten their own book-shelves and to benefit the Association by presenting to its Library copies of such books as they seldom make use of. The Library will be the first room completed and fitted in the Laboratory Building, and accordingly the Secretary of the Association will be glad to hear at once from any person who may propose to make presentations of books as suggested above. The hearty thanks of the Council will be due and will be given to those who may thus assist the work of the Association. A list of donors of books will be permanently displayed in the Library of the Plymouth Laboratory.

IX. During the past year the Council has received applications for assistance and advice in regard to matters relating to the general purposes of the Association from various public bodies. It has been in correspondence with the Russian Embassy, the Agent-General for the Colony of New Zealand, and the Inspector of Fisheries of the Board of Trade. The Council desire to take this opportunity of stating that, in view of the national and representative character of the Association, it appears to them important that it should be generally known that they are willing and anxious to co-operate with individuals or associations in any part of the British Islands who are engaged in the study of the natural history of marine fishes, or in researches in Marine Biology.

X. The Council records with deep regret the death of one of the Vice-Presidents of the Society, the distinguished naturalist, Mr. George Busk.

XI. The Council does not propose any alteration in the list of Officers, Vice-Presidents, and Council for the ensuing year.

The following names will therefore be submitted to the meeting for election:

For President—Professor Huxley.

For Vice-Presidents—The Duke of Argyll, K.G., F.R.S.;

the Duke of Sutherland, K.G.; the Duke of Abercorn; the Earl of Dalhousie, K.T.; Lord Walshingham, F.R.S.; Professor Allman, F.R.S.; Sir John St. Aubyn, Bart., M.P.; Sir Edward Birkbeck, M.P.; W. H. Flower, Esq., C.B., F.R.S.; Sir John Lubbock, Bart., M.P., F.R.S.; and Prof. Alfred Newton, F.R.S.

As Elective Members of Council—Prof. Moseley, F.R.S. (Oxford), Chairman; C. Spence Bate, Esq., F.R.S. (Plymouth); Professor Jeffrey Bell, F.Z.S. (British Museum); W. S. Caine, Esq., M.P.; W. T. Thiselton Dyer, Esq., C.M.G., F.R.S. (Royal Gardens, Kew); John Evans, Esq., D.C.L. (Treasurer, R.S.); A. C. L. G. Günther, Esq., F.R.S. (British Museum); Professor Herdman (Liverpool); E. W. H. Holdsworth, Esq.; Professor McIntosh, F.R.S. (St. Andrew's); Professor Milnes Marshall, F.R.S. (Manchester); G. J. Romanes, Esq., F.R.S.; P. L. Sclater, Esq., F.R.S. (Sec. Zool. Soc.); Adam Sedgwick, Esq., F.R.S. (Cambridge); Professor Charles Stewart, F.L.S.

As Hon. Treasurer—Frank Crisp, Esq., V.-P. L.S., and

As Hon. Secretary—Professor E. Ray Lankester, F.R.S.

XII. The Council have again to express their sense of the great boon conferred upon the Association by the Council of the Linnean Society in permitting the meetings of the Association to be held in the rooms of the Society.

Notes on the Fishing Industry of Plymouth.

By

Walter Heape, M.A.,

Resident Superintendent of the Plymouth Laboratory of the Marine Biological Association.

In the following Notes on the Fishing Industry of Plymouth the information obtained is divided into three sections, which are again subdivided as follows:

I.—Methods of fishing, localities fished, and fish caught. There are eleven different methods of fishing carried on in Plymouth:

1. Beam trawling. 2. Drift-net fishing. 3. Moored-net fishing. 4. Seine fishing. 5. Bultering, or long-line fishing. 6. Hand-line fishing. 7. Eel spearing. 8. Mullet trapping. 9. Crab and lobster fishing. 10. Shrimp and prawn fishing. 11. Oyster, mussel, and cockle fishing.

II.—Industries connected with the fishing trade carried on in Plymouth:

1. Boat building. 2. Sail making. 3. Rope making. 4. Fish-line making. 5. Net breeding. 6. Fish curing. 7. Fish-skin curing. 8. Fish-oil manufacture. 9. Ice manufacture.

III.—Methods of ownership, wage, apprenticeship, insurance, and sale of fish:

[Note.—Mr. Heape's notes are intended to furnish information which will be useful as a preliminary to the investigations to be carried out in the Plymouth Laboratory when it is completed. They are necessarily not the result of original observation, but are compiled from various sources. They have not been published in any shape before the present date, August 8th, 1887.—E. R. L.]

1. Payment of trawlers. 2. Payment of drifters. 3. Payment of hookers. 4. Systems of payment compared. 5. Insurance of trawlers. 6. Insurance of drifters and hookers. 7. Methods of selling and buying fish.

I.—Methods of Fishing. Localities Fished and Fish Caught.

1. *Beam Trawling.*

Trawling Smacks.—The boats used for beam trawling in Plymouth average about forty-three tons (43·62) ; they are cutter or yawl rigged, and are manned by a skipper, two men, and a boy ; they are, as a rule, very fast sailers and excellent sea boats.

In confirmation of this latter statement it is most satisfactory to be able to state that, in spite of the heavy weather frequently encountered by the smacks, and the great traffic carried on over a considerable portion of the fishing grounds, during the last seven years there have been but two trawlers lost, one at sea and one in the Sound. Both losses were due to collision. Two lives only have been lost during this time, both these being lives of men drowned in the former of these two accidents.

There are seventy-seven trawlers now sailing from Plymouth, for the most part owned by fishermen, many of whom are skippers of their own boat.

For some years the size of trawlers has been on the increase, the newer vessels being the largest in the port, viz. fifty-five tons. At the present time, however, there is a tendency on the part of the fishermen to prefer smaller boats, about forty tons. Those of them in favour of this change assert—

1. That there is less wear and tear in the smaller than in the larger boats, and the cost of keeping the boat in good order is consequently proportionately less in the smaller than in the larger boats.

2. That the small boats catch, in spite of the smaller

sized trawl they are obliged to use, as much fish as the larger boats; the reason of this according to my informants, being, that the smaller sized boats trawl more regularly than the larger boats, increase or decrease of wind during trawling having less effect upon them than upon the vessels of greater tonnage.

In explanation of this, I may state that only sufficient sail is made upon a vessel towing her trawl to enable her to drag it at a certain speed, say from one to three knots an hour. Any sudden and considerable increase of wind driving the boat too rapidly, lifts the trawl off the bottom, so that the fish escape underneath, while a falling off of wind on the other hand, stops the boat altogether, or causes it to trawl too slowly and to make the trawl dig too much into the ground and pick up too much sand or weed. These variations of the wind act more readily upon the larger than upon the smaller vessels, hence the latter are considered to trawl more regularly than the former, and to catch quite as much fish.

3. That the crew of three men and a boy, while ample for the smaller boat, is scarcely sufficient for the large boat, and yet the difference is not sufficient to oblige the latter to ship an extra hand. The smaller boats are, therefore, more readily handled.

4. That the smaller boats cost less than the larger in the builder's yard.

The obvious advantages of a larger boat are:

1. Increased speed in getting out to the fishing ground and home with fish; and, therefore, increased time for fishing and command of the early market to some extent.

2. The power of using a larger-sized trawl, covering more ground than the trawl of a smaller vessel; and

3. Greater storage capacity.

If trawling here was conducted, as in the North Sea, on the "fleeting system;" if the trawlers travelled further to sea and remained longer from home, the larger vessels would be a necessity. A North Sea trawler may be as much as eighty tons or even more.

System of Fishing.—The fleet system of fishing is not in use in the Channel. That is to say, there are no "carriers," steam, or sailing vessels which collect fish from the trawlers on the fishing grounds and bring it to market.

Each smack carries its own fish home. Hence fishing is always carried on comparatively near the shore, and the area fished over by boats landing their fish in Plymouth is necessarily small. This system is called the "single boating system."

Why the fleet system of fishing is not carried on here I do not know, but one of the reasons advanced why it should not be is, that gales in the Channel, especially when from the south-west, are accompanied by very much heavier seas than are usual in the North Sea, and the dangers attending the fleeting system would be greater here than they are even in the North Sea.

The chief danger to be encountered by men fishing on the fleeting system is the exposure in small open boats while carrying the fish from the smacks to the "carrier" which is to take it to market. This work has to be done in all weathers, and is probably the most dangerous work encountered by fishermen.

Steam Trawlers.—There are no steam trawlers in Plymouth, and a recent attempt to introduce two such vessels here has, I am informed, not met with encouragement.

The fishermen are not favorable to steam trawlers, but do not fear competition from them.

They are of opinion that the expenses attending steam trawling, both the orginal cost of the vessel and the working expenses, are more, in proportion to the catch of fish, than the expenses of sailing smacks. They are also of opinion that a steam trawler, although able to fish in calm weather when the sailing smacks are becalmed, would be unable to fish in the heavy seas frequently encountered in the Channel by their cutters and yawls, whose sails only keep them sufficiently steady for trawling purposes.*

* In Falmouth there are six steam vessels, which are used both as steam trawlers and, when required, as tugs. I have yet to learn the fishing grounds they frequent and the effect of rough weather on their fishing returns. I

The Trawl.—The trawl is of the ordinary pattern.

Beam.—Runners.—A wooden "beam," usually made of elm, of 44 to 47 ft. long, according to the size of the boat using it, is fixed on two iron "runners"—the "trawl-heads"—and by this means raised 2 to 3 ft. from the ground.

Net.—A purse-shaped net, open at both ends and about 85 ft. long, is attached, the upper edge of its mouth to the beam of the trawl, the lower edge to a rope—the "ground rope"—which is in its turn fastened to the lower portion of the runners. By this means the mouth of the net is kept open. The hinder end of the net, which is much narrower than the mouth, is closed during trawling by a rope, which is tied round it; and when the trawl is hauled up with the fish in it, it is hung suspended over the deck, this rope is cast loose, and the catch falls out on to the deck.

Net breeding.—The trawl nets are made or "bred" by the fishermen themselves while at sea. They are made of hemp twine, and are prepared for work when completed by steeping them in a hot solution of tar. The mesh of the net varies from about 4″ square at the mouth to $1\frac{1}{2}$″ at the hinder or "cod" end of the net.*

Wear of Net.—The upper part of the net, or "back," lasts—with good luck, *i. e.* if no anchors or wrecks or rocks are come across—for twelve months. The lower part, or "belly," on the other hand, is usually worn out in four months, and this in spite of the fact that it is guarded by extra netting; the lower part of the "cod end" of the net wears out faster than the other lower portions on account of the collection of material at that end and consequent heavier weight on the ground.

Spans.—Two ropes called the "spans" or "bridles," each about fifteen fathoms long, are attached one to each trawl-head and to these "bridles" is attached the "trawl-warp" by which the net is towed.

understand, however, that they do not bring in a good return for their original cost.

* For details of the structure of the trawl net, "pockets," "valves," &c., see No. 11.

Size of Trawl.—The trawl is hauled on board Plymouth trawlers generally if not always on the port side, and the beam of the trawl is of such a length that when hauled on board one of the runners is fastened just ahead of the aftermost stay, and the other made fast on a level with the extreme end of the stern of the vessel.

Accordingly, a fifty ton trawler will use a trawl with a 46 ft. beam, and this is found to be about the size of trawl which such a vessel can tow and work most satisfactorily. A smaller vessel will use a smaller trawl.

Trawling.—The trawl is towed in the direction of the tide, and owing to the complicated tides of this portion of the Channel, great experience and the closest observation is required.

As an example of the complication of the currents in the neighbourhood, it may be mentioned that the tide flows in the Channel between the mainland and the Eddystone for three hours and half after it has turned at the Eddystone, and for three hours after high water in the Sound (No. 14).

A breeze of wind is required for satisfactory work, in fact, the weight of the trawl when partially full is so great that in a light breeze the smack cannot tow it.

The length of the tow-rope is so adjusted that the trawl should drag as lightly as possible over the ground without "lifting." The shorter the tow-rope the more weight is taken off the ground.

The hardest work in connection with this method of fishing is the hauling up of the trawl. The trawl hawser is, by means of a winch, hauled in over the bows of the boat, which is laid to during the process.

In summer weather, when the fishing ground is covered with sand and "scruff"* and the sea smooth, the labour of hauling up the trawl is very great. The net gathers a great amount of mud, weed, and "scruff" at such times, which is a dead weight to lift, and the operation may take a couple of hours. With a slight sea running, however, the boat pitches, and each time she dips a fathom or so of slack rope can be quickly wound in without trouble.

* See page 53.

In favorable weather, hauling in the trawl takes about an hour. As much as three tons of fish is at times brought on board in a single haul, but probably the average weight of fish would be about four to five cwt. Several smacks in Brixham are fitted with a donkey engine to do the work of hauling in the net, and one Plymouth smack is provided with this convenience, but it is not usual in the boats on this part of the coast as it is on board the large trawlers on the east coast.*

Day Trawling.—Most of the trawling grounds are within a few hours' sail of Plymouth. In favorable weather the trawlers generally leave port between 4 and 6 a.m. and return during the following afternoon or night, from 4 to 12 p.m., sailing again the next morning at 4 a.m. This they do from Monday morning until Friday night, if the weather remains suitable for so long. Saturday and Sunday the men spend ashore.

Night Trawling.—The Brixham trawlers (Brixham is the largest trawling port on the Channel coast) on the other hand trawl more during the night than during the daytime. The following reason has been given for this: more "prime" or "first-class" fish is caught at night than during the day, the greater number of "coarse" fish, or so-called "offal" fish, being caught during the daytime. At Brixham there is but a small market for coarse fish, while in Plymouth there is a much more ready sale for that class of fish.

If night work is more productive than day work it is much more dangerous. A vessel with her trawl down is helpless and runs considerable risk of being run down by large steamers and vessels at night. This risk on the Plymouth fishing grounds is probably greater than on the grounds mostly frequented by the Brixham smacks.

Summer Fishing, &c.—In the summer season, when trawl fish is scarce in the Channel, most of the Brixham boats go

* It appears that the reason why a steam winch is not shipped on board Plymouth smacks generally is, that if it was used, a larger share of the proceeds of the fishing would be absorbed by the boat-owner and there would be less available for the fishermen, while at the same time the usual crew would be required to work the vessel.

to the North Sea to fish, and boats have gone there from Plymouth.

During the last three summers some Plymouth smacks have gone over to the south coast of Ireland to fish. In 1885 twenty-one boats went there, and they had considerable success; but in 1886, although they report excellent trawling grounds and abundance of fine fish, they did not make as much money as the few boats which remained on the home grounds. This was partly owing to the calms which prevailed off the Irish coast during last summer, and the inability to trawl on that account, and partly to the fact that the few boats (only thirty) which remained in Plymouth found a ready sale for the limited supply of fish they brought to market.

When the boats fished off the Irish coast they clubbed together, and divided equally the proceeds of their fishing. Some of the company were fitted with bunkers, in which the fish was packed in ice, and they were used in turn to carry the fish from the fishing ground to Plymouth.

Although as a rule the trawlers are engaged in fishing all the year round, yet in summer time some of them are used as small coasting cargo boats, chiefly for the carriage of potatoes between Ireland, Scilly, and Tenby.

Trawling Grounds.—The trawling grounds in the neighbourhood of the port may be grouped into two districts, the one within a line drawn from the Eddystone to Dodman Point, the other outside that line. A line of rocks runs between these two points, over which it is, except in a few places, impossible to trawl, and thus forms the two districts.

It is, of course, essential that trawling grounds should be free from rocks or other obstructions, wrecks, &c.; and, indeed smooth ground, if it is formed of rock and not covered with sand, will chafe and tear the net, and cannot be trawled over.

Variation of Condition of Ground.—The condition of the inner ground trawled over varies greatly, according to the time of the year.

During the summer months, when there is but little wind and sea, the trawling ground becomes covered with sand and

mud, masses of seaweed and beds of so-called "scruff;" the latter are composed of a few oysters in clumps, great quantities of pecten, and polyzoa (Mucronella and Salicornariadæ I have seen in very considerable masses hauled up in the trawl), to such an extent in fact, that the trawl net is sometimes unable to bear the weight when being hauled out of the water and breaks away with all it contains. In the late autumn, winter and early spring months, on the other hand, when storms are prevalent, the ground becomes cleared of these obstructions and after trawling for six or eight hours the net may be hauled in with not more than one or two cwt. of débris.

This frequent alteration of the bottom of the sea, causing as it does variation in the kinds of fish caught and in the invertebrate Fauna, will be of great interest to investigate. It may be added that most of the scruffs lie west of the Eddystone rocks and parallel to the coast line.

In the following account of the trawling grounds fished by the Plymouth smacks it must be understood, that the localities mentioned for each season of the year are the favourite fishing grounds for that season; but smacks are so dependent upon the wind and weather that it is not possible for them always to reach or remain on their favourite grounds.

It may be taken as a general rule that in a strong north wind the smacks fish near in shore; when the wind is strong from the north-east they choose ground east of the Sound; when strong from the north-west they take westerly ground. Southerly winds are the most favorable. The trawlers of Plymouth fish, with the rarest exceptions, in at least twenty fathom water; the average depth fished in is probably between thirty and forty fathoms, while fifty fathoms may be considered as the maximum.

Date.	Marked on Chart.	Position and Direction.	Ground.	Fish Caught.
June and July . .	...	...	...	Very little fish caught. Boats go to Scilly, Ireland, and Tenby, to carry potatoes, and to Ireland off South Coast to fish.
July	A.	Eddystone to Dodman Point	Shelly and hard	Soles, rays, flatfish, gurnard.
,,	B.	Fowey Harbour to Mewstone, within three miles of shore	Mud	Whiting and flatfish, especially plaice.
,,	C.	Bolt Head to Raeme Head or Mewstone	Mud or sand	Whiting and flatfish.
,,	D.	Start Bay, inside Skerry Bank	Sandy	Plaice and soles.
,,	E.	On Skerry Bank and southwards. *N.B.*—Skerry Bank slopes gradually on west side, and abruptly on east side. Can trawl from Start Bay over Bank to the outside, but not back again.	Shelly outside	Soles.
,,	F.	Dartmouth Harbour, N.E., to off Beer	Sandy	Flatfish and whiting.
,, *Night* . . .	G.	Mewstone to Fowey, outside	Shelly	Bream, red mullet, thornback, gurnards, brill, and rarely turbot.
,, *Night* . . .	H.	Dartmouth Harbour, S.E. by E., to N. edge of East Scruffs	...	Red mullet and bream.
,,	I.	Pendennis Castle to the north of Helford River	...	Plaice and soles (Small steam trawlers from Falmouth used to and sometimes now fish these spots in the summer months.)
,,	J.	Gerran Bay	...	Plaice and soles
,,	K.	Verryan Bay	...	Plaice and soles

Aug. to Christmas	A. to H.	As given for July	As for July, except where muddy or sandy or shelly they become clearer and harder towards last months of year	Turbot and brill appear.
Nov. to Christmas	L.	East Rutts to Fowey Harbour, inside Eddystone, or if wind will not serve then outside Eddystone	Shelly outside	Hake now taken.
Christmas to Feb. (end of Feb.)	M.	Twenty to forty miles S. by E. of Plymouth to point where Eddystone bears N.N.W., trawl W. until open St. Anthony's Light (Falmouth Harbour)	...	Tub, sole, dory, brill, turbot, gurnard, and ray. Long-finned gurnard caught here.
,,	N.	Thirty miles S.S.E. of Start Point and trawl E. nearly as far as Portland ("French ground"), used by Brixham trawlers chiefly	...	Mullet, ray, gurnard, and pout.
March to June (end of June)	O.	Twenty miles S. and by E. of Michael's Mount to Wolff Rock	...	Common flatfish, gurnard, and ray, in large quantities. Turbot, brill, dory, and tubb. In May hake taken.
,,	...	A few boats may fish over ground given for July to Christmas, but nearly all shoot nets only over ground mentioned above.	...	...
,,	P.	Bolt Tail to Dodman Point.	...	Tub, red mullet, grey gurnard.

Trawl Fish.—The following is a list of the fish caught by trawlers which are used for food:

ELASMOBRANCHIA:

Raia alba	Ray.
,, circularis	
,, batis	Skate (may weigh as much as four cwt.).
,, clavata	Thornback.

TELEOSTEI.—*Acanthopterygii:*

Capros aper	Boar fish.
*Trigla lyra	Piper.
,, obscura	Long-finned gurnard (M.).
,, cuculus	Red gurnard.
* ,, hirundo	Tub.
,, lineata	Streaked gurnard.
,, gurnardus	Grey gurnard.
*Mugil capito	Grey mullet.
*Mullus barbatus	Red mullet.
*Zeus faber	Doree.
*Scomber scomber	Mackerel.
*Cantharus lineatus	Black bream.
*Pagellus centrodontus	Common sea bream.
*Labrax lupus	Bass.
Caranx trachurus	Scad, or horse mackerel.

Anacanthini:

*Rhombus maximus	Turbot.
* ,, lævis	Brill.
*Solea vulgaris	Sole.
,, lascaris	Lemon sole.
,, variegata	Thickback.
Pleuronectes limanda	Dab.
,, platessa	Plaice.
,, flesus	Flounder.
Arnoglossus megastoma	Merry sole.
,, laterna	Megrim.
*Hippoglossus vulgaris	Halibut.
*Gadus morrhua	Cod.

Anacanthini :

*Gadus æglefinus . .	Haddock.
„ pollachius . .	Pollack.
„ merlangus . .	Whiting.
„ luscus . . .	Bib, or pout.
*Merlucius vulgaris . .	Hake.
Molva vulgaris . .	Ling.

Physostomi :

Conger vulgaris . .	Conger.
Clupea pilchardus . .	Pilchard.
„ alosa . . .	Alewife, or shad.

Ganoidei :

Acipenser sturio . .	Sturgeon. Generally two or three caught each year, Oct.—Dec.

Those marked with an * in the foregoing list are considered to be "first-class" fish, "prime," or "head fish." The remainder are called "second-class" fish, "seconds," or "offal" fish, and are of less value than the former.

Movements of Fish—Summer and Winter.—With regard to the movements of fish, speaking generally, it may be said, fish draw near to the shore as the year advances from spring to summer. The summer fishing is carried on near to the land, and the trawlers haul their nets as near to the rocks as they dare to go.

In the winter months, and especially when snow falls, the fish go away into deeper and warmer water, consequently, the fishing ground is farther away from port.

Night and Day.—Again, fishermen say that at night more soles are caught than during the daytime, while round fish rise from the bottom at night, and therefore more are caught during the daytime than at night. During the day the soles and flatfish are believed to "sand" themselves, *i. e.* cover themselves over with sand.

In the North Sea it is said that night fishing is more profitable than day fishing, because haddock (*Gadus ægle-*

finus), cod (*G. morrhua*) and ling (*Molva vulgaris*) rise from the ground during the daytime and sink again at night (No. 1).

As a rule in the Channel but little flat fish is found on shelly ground.

Effect of Storms.—It is a matter of general remark among trawlers that immediately after heavy south-west storms, the fish ordinarily caught on the trawling grounds in fine weather, between the Eddystone and Raeme Head and to the eastward, are not to be found there; their place being taken by rock-fish, conger (*C. vulgaris*), bass (*Labrax lupus*), bream (*Pagellus centrodontus*), pout (*Gadus luscus*), ling (*Molva vulgaris*), &c., and with these fish larger quantities of kelp. It would appear probable that the rock-fish are driven from their usual habitat by the danger of the force of the water upon the rocks, and seek safety on smooth ground (the trawling ground), but with regard to the fish usually found on this ground (flatfish, gurnard (*Trigla*), mullet (*Mugil capito*), whiting (*Gadus merlangus*), hake (*Merluccius vulgaris*), &c.), which are not caught there for a short time immediately after such storms, the fishermen do not know what becomes of them, but assert they go into deeper water.

It must be noticed further that large soles and plaice, the finest of which are to be found near rocks in fine weather, are caught in increased numbers on the smooth ground away from rocks, after storms have occurred. Should this be true—and there appears to be no room for doubt that my informant, who is an experienced trawler, speaks correctly—it would follow that the effect of storms is felt at greater depths than is usually believed.*

The depths of the rocks from which the conger, ling, &c., have been driven is, say from ten to thirty fathoms. But from depths of forty fathoms, stones, lumps of coal, &c., are brought up in the trawl, bearing every appearance of having been in constant movement, while trawls which have been lost in

* It has been calculated (No. 13) that a wave 300 feet long, and 6 feet from crest to trough, will cause an alternating current of 2 feet a second on the ground at a depth of six fathoms.

that depth of water in heavy weather, have been found a considerable distance from the place where they were lost, with their "runners" bright as if they had been towed along.

Bellamy (No. 3 *b*) states the effect of south-west storms is to drive the generality of fish to deep water.

Breeding of Fish.—Of the breeding habits of fish there is but little known by the fishermen. From June to October Whitsand Bay is found to be full of small young flat fish of various kinds, and would appear to serve, if not as a breeding ground for these fish, at any rate as a nursery for their young during these months. Soles are taken full of roe about March near Plymouth, and in April and May in Mounts Bay.

Besides fish the trawlers catch the following marketable commodities :

Crabs (*Cancer pagurus*).—Sometimes caught in considerable numbers, more by night than by day, however. The fishermen believe it buries itself in the sand during the day.

Squid (*Loligo*).—Caught in very considerable numbers ; it is the favourite bait of the hook and line fishermen.

"*Queens*" (*Pecten*).—They are used for food and bait. During calm summer weather they are brought up in the trawl in very great numbers.

2. *Drift-net Fishing.*

There are not a great many "drift-boats" owned in Plymouth, although a considerable trade is carried on, on the fish quay, in drift-net fish landed here from boats belonging to other ports. The centre of the drift-net fishery in the west country is at Penzance.

Boats.—From Plymouth about twenty boats, averaging, say, twenty tons each, sail regularly to fish for mackerel (*Scomber scomber*), or herring (*Clupea harengus*) or pilchard (*Clupea pilchardus*). These boats are lugger-rigged, and are manned by a skipper, four hands and one boy.

Besides these there are, say, twenty-five smaller boats, "hookers," between ten to twenty tons each, dandy rigged and manned by a skipper and three men, which fish with a few

drift nets for herring and pilchard during the season when those fish frequent these shores.

During the herring and mackerel seasons there may be from 150 to as many as 300 or 400 sail, belonging to other ports, which bring their catch to Plymouth each day.

Fishery.—Drift fishing is carried on at night; the early part of the night and the very early morning, being considered the best times.

Shooting Nets.—The nets, which vary in size and size of mesh according to the kind of fishery, and even of the district fished, when "shot," lie to windward of the boat; they are buoyed and weighted in such a manner that they hang straight down from near the surface and drift with the current. The boat to which they are attached drifts with the nets, sail being taken off, and when heavy mackerel nets are used the mast is "stepped."

As the boat lies to leeward of the nets, and the wind acts more on the boat than on the nets, the former drifts faster than the latter, and so hauls them "taut." The nets hang like a wall in the water, and the fish coming against them try to swim through the meshes, and are caught by the gills.

The method of "shooting the nets" among Plymouth boats is as follows:—The nets are shot on the lee side of the boat while it is going before the wind. Eventually the boat brings up to leeward of the nets, generally arranging they shall lie on the starboard side.

Method of Fishing.—The nets are shot about sunset, and an hour or so afterwards the first one or two nets are hauled in to see if there are any fish in them. Should fish be about they may be left until near daylight, or hauled about midnight and shot again, and again hauled in before daylight. If fish are not in the nets when they are examined they haul them in and cruise to find a better place, and may shoot and haul the nets several times before finding fish.

"*Briming.*"—In summer, at times when there is no moon, the fish may be found by the phosphorescent light they cause when disturbed.

The boats cruise about, and every now and then the men

jump heavily on the deck. If fish are near, this disturbs them, and they can be traced darting along far down in the water by means of the phosphorescent light which their movement causes in the small marine organisms. This light is at times so brilliant, that it actually flashes through the water, and is reflected onto the sails of the boat. The phosphorescence is locally known as "brimming."

Nets Made.—The drift nets are not made, or "bred" as it is called, in Plymouth; they are obtained chiefly from Porthlevin, Bridport, St. Ives, and Scotland. They are made of cotton, and are sent from the manufacturer "white." The fisherman then treats them in one or other of the following ways:

Nets Prepared.—They are first steeped in a hot solution of catechu for one to twelve hours, and dried by being squeezed between two rollers (as in a mangle). They may be steeped and then dried in this way three or four times. They are then steeped in a hot solution of tar and dried in the air. After going through the tarring process they may be tanned in bark liquor as much as three or four times before being used. This latter tanning process is gone through once perhaps every two months, or even less, according to the amount the nets are used.

Mesh.—The sizes of the mesh of the different kinds of nets used and their lengths, vary in different ports of the west country. Unless, therefore, a port is specially mentioned in the following accounts of nets, they must be considered as referring to Plymouth only.

Mackerel Fishing.

Time of Year.—Mackerel fishing is carried on nearly all the year round, from January to June, and then again from September to November. There may be an interval of eight or nine weeks in the summer during which mackerel are not caught, but often this time is reduced; the late fishing, on the other hand, may, instead of lasting three months, be continued only two or three weeks.

As a rule, but few fish are caught during May and June,

but the supply and the time the fish arrive off the port vary greatly each year.

Boats.—Besides the boats of the port, boats which hail from other ports, and which land mackerel here during the time of year when they are most plentifully caught in the neighbourhood, may be estimated at 150 to 400.

The ports from which they sail are as follows:

East Country Boats.—Yarmouth, Lowestoft, Brighton, Folkestone, Rye, and Newhaven.

West Country Ports.—Looe, Mevagissey, Falmouth, Porthleven, Newlyn, Mousehole, Fowey, Penzance, and St. Ives.

A few boats also come from Guernsey, Scotland, and the Isle of Man.

Nets.—The mackerel nets in use here are three fathoms deep, and the mesh 1·44″ to 1·38″ across, or twenty-five to twenty-six meshes to the yard.

Cornwall boats fishing for mackerel off Scilly use nets with a mesh of 1·44″, or twenty-five meshes to the yard; but many boats in other ports and some in Plymouth use nets whose mesh is 1·3″ across, or twenty-seven to the yard.

Each boat shoots sixty to eighty nets of sixty yards each; that is to say, a "fleet" of nets is two to three miles long.

Nets "Shot."—The nets are buoyed by corks at intervals of about a yard, and, because mackerel swim high in the water when in shoals, the top or "back" of the net lies nearly upon the surface of the sea. It is on account of the mackerel nets lying so near the surface, and in consequence of the great length of net "shot," that great losses are experienced in this fishery. A sudden storm may almost completely ruin a fleet of nets, and a steamer or vessel cuts through them frequently.

In order to be able to recover nets which have been so cut through by vessels, a line, the "foot-line" by which the nets are hauled in, is attached to each net, and hangs six fathoms below them. This line, being 54 feet below the surface, is well out of reach of any vessel's keel.

Fishing Grounds.—The ground fished by boats bringing their catch to this market may broadly be stated to be, the whole extent of water from the coast between Start Point

and Dodman Point to a parallel line drawn, forty miles south of the coast.

Winter Fishing Ground.—In January (*i. e.* during the "winter fishing"), as a rule, the boats go to the ground furthest away from the coast; as the season advances the fish approach the shore, and the fishing is nearer home.

Summer Fishing Ground.—During the "summer fishing" season the fish are generally found from four to twelve miles from the coast.

The early fishing is to the eastward, the late fishing to the westward of the port.

It will be understood these remarks are only approximately correct, owing to the variable supply of fish and the somewhat irregular course of their migrations.

Fishery Productive.—This fishery appears to be very productive, and no falling off in the supply of fish is, I believe, reported.

Herring Fishing.

The herring fishing for this port lasts from November to the end of January.

Boats.—The boats from other ports, which may number about 200, fishing here at this time hail from west country ports.

Nets.—The herring nets are each 120 yards long and three fathoms deep, twelve nets forming a "fleet," which is, therefore, nearly a mile long. The mesh is 1·125″ or 1 058″ across, *i. e.* thirty-two to thirty-four meshes to the yard in some cases; many boats, however, use smaller meshed nets, about ·97″ across or thirty-seven meshes to the yard. This latter is about the mesh used for pilchards, and these nets are practically pilchard nets, and may be used to catch both fish.

Nets "Shot."—The nets are buoyed at intervals of five to seven fathoms, and the "back" of the net lies about three and a half fathoms below the surface; this distance is varied, however, according to the depth of the water fished and the depth at which the shoals are swimming.

On account of the depth at which the nets lie, and their consequent safety from accident by being cut by passing

vessels, it is not considered necessary to provide for their safety by hanging a foot-rope below them. The "foot-line" lies, therefore, on the "back" of the net.

Another reason and one which renders this arrangement of the foot-rope necessary is, that at times the water fished is so shallow that the nets themselves have to be hauled nearer the surface (the lines by which they hang from the floats being shortened), to prevent them dragging along the bottom.

Fishing Grounds.—The grounds fished extend from the Mewstone to Bolt Tail from one to eight miles from the shore.

Fishery.—For the last two years this fishery has not been so good as usual.

Pilchard Fishing.

The pilchard fishery is very variable in extent, and the times during which it is carried on is also quite uncertain.

If there is a good supply of fish it lasts about from July to Christmas, and is divided into two sections:

1. A summer fishery, lasting during July and August.
2. A winter fishery, from September to Christmas.

Boats.—Besides Plymouth boats, about 120 small boats belonging to west country ports, Mevagissey, Falmouth, Looe and Polperro, bring fish to this market.

Nets.—The pilchard nets are each 120 yards long, and a fleet consists of twelve to fifteen nets forming a line of nearly a mile in length. They are six fathoms deep, and those used for the summer fishery have meshes ·95″ across or thirty-eight to the yard, while those used for the winter fishery have meshes 1″ across or thirty-six to the yard. Old shrunken herring nets are frequently used for the pilchard fishery.

Fishing Grounds.—The grounds fished are as follows:—

1. During the summer fishery, between Raeme Head and Looe Island, near in shore. The fish work their way eastward towards the autumn; and

2. During the winter fishery the nets are shot off Plymouth, and, may be, as far east as off Bigbury Bay, but chiefly from seven to eight miles south to south-south-west of Plymouth Sound.

Condition of Winter Fishery.—For the last two winter seasons pilchards have been now and then so cheap on the quay, that fishermen have taken their catches out to sea and thrown them overboard rather than sell them for the small sums offered. They have been sold as cheap as 2s. per 1000 recently, and indeed, now (November, 1886), boats are fishing with only half a fleet of nets in order to reduce the catch and keep up the price of the fish. These boats are endeavouring, by fishing with hook and line for hake, to make their work pay.

Condition of Summer Fishery.—The summer fishery for pilchards, on the other hand, has largely decreased in Plymouth. It has been taken out of the hands of the Plymouth fishermen by the fishermen of Looe, whose boats appear to be more suitable for the work. At this latter port the increase of boats in the last few years is estimated at 30 per cent.

3. *Moored-net Fishing.*

Boats.—There is but little fishing of this description practised by Plymouth boats. A few of the line fishing boats during the herring season carry on moored-net fishing. These are chiefly Cawsand Bay boats.

Nets.—The nets are similar to drift nets; but instead of drifting with the tide, they are moored by means of grapnels, and are "shot" in the direction in which the tide runs.

Fish.—The fish caught is the herring.

Ground Fished.—The ground where the nets are set is almost confined to the mouth of Cawsand Bay.

4. *Seine Fishing.*

Seine fishing is carried on all down the coast as far as Land's End. The seine is used to catch mackerel, pilchards, sprats (*Clupea sprattus*), and mullet (*Mugil capito*), but not herrings.

The great centre for this method of fishing is at St. Ives, on the west coast of Cornwall.

There are several kinds of seines.

Seine Proper.—The seine proper is a long net, deeper in the middle or "bunt" than at the ends ("sleeves" or

"wings"). A large seine is about two hundred fathoms long and ten fathoms deep at the "bunt."

Method of Fishing.—It is carried in two boats, which lie in wait for shoals of fish near the land.

The fish are, during the time this fishery is carried on, swimming near the surface of the water, and a shoal is readily observed by means of the colour, or, especially in the case of pilchards, by the oily appearance of the water covering them.

The two boats row round the shoal, or as much of it as the length of their net will allow them to compass, shooting the net as they go; the two ends of the net are brought together and it is hauled to the shore, where it is moored, the fish contained therein being taken out as required with smaller seines called "tuck seines."

Tuck Seine.—A tuck seine is, say, seventy fathoms long, but much deeper in the "bunt" than an ordinary seine, so that it may be hauled in under the fish and raise them to the surface, to enable the men to get them out of the water.

Ground Seine.—A third kind of seine, the ground seine, is used here. It is much smaller than the seine proper, and is used close to the shore. A rope attached to one end is left on shore, a boat then rows in a semicircle, and the net is shot as the boat goes along. Finally, both ends are brought ashore and the net hauled bodily on to the land. These nets may be quite small, and are readily worked. Their structure, although differing in detail, is very similar to the large seine.

Mackerel Seining.—Mackerel seining is carried on from June until the end of July all along the coast from Start Bay to Land's End. Most of the seines here are owned in Cawsand, at the mouth of the Sound. This is a favourite place for carrying on the fishery, and there the seine boats, full of nets, may regularly be seen lying near the mouth of Cawsand Bay, waiting for a shoal of fish.

Pilchard Seining.—Pilchards are seined during the summer. At Cawsand this fishery is carried on on a small scale.

It is said that some years ago the pilchard fishery at Cawsand was conducted on a very considerable scale, and

the large cellar accommodation in some of the houses of the village is a partial proof of this; now, however, there is but little business done. All along the coast, from the Land's End to the Lizard, this fishery is conducted, and at St. Ives it is an important industry.

Mullet Seining.—Mullet seining is carried on up the estuaries all through the autumn.

Sand Smelt Seining.—Sand smelts (*Atherina presbyter*) are seined in the estuaries about September.

Sprat Seining.—Sprats are seined both in the Sound and along the coast.

Ground Seine Fish.—Ground seine fishing is carried on along the rocks of the Sound at low water, bass (*Labrax lupus*), mullet, &c., being caught. These nets are from about twenty to fifty fathoms long.

5. *"Bultering" or Long Line Fishing.*

Boats.—There are, say, sixty boats following this method of fishing. They are mostly about twelve tons, are "dandy" rigged,* and manned by a skipper and three men.

About thirty-five of these boats regularly fish with long lines, but the remainder, say twenty-five and these are the largest of the fleet, fish for herring and pilchard with drift nets during the season these fisheries are carried on here. These boats carry only a small "fleet" of drift nets, suitable for herring and pilchard, and do not fish for mackerel.

Besides the home bulterers, boats from Looe, Polperro, and other ports in the neighbourhood bring fish to this market at times.

"Bulters."—The bulterers fish by means of long lines or "bulters," of from about 2500 fathoms length and less. To these lines hooks are attached at intervals of 1½ fathoms, by means of "snoods" about 3 feet long, made of strong fishing line. There are therefore about 1666 hooks on a line 2500 fathoms long.

Lines "Shot."—The lines are "shot," or laid down at

* A "dandy" rigged boat is somewhat similar to a yawl, but differs in certain details, the most obvious of which are the position of the mizzenmast—it is stepped right aft—and the kind of sail which it carries—a lug-sail.

right angles to the direction in which the tide runs, so that the snood carrying the hook may be washed free from the main line, and they are attached at either end to buoys of cork, which carry a flag to show their position.

Times of Fishing.—The lines are "shot" at any time *after* sunset, left for some time, and hauled in again when the several directions of the wind and tide render it possible to do so. A "weather-going tide," as it is called, is necessary to enable these long lines to be hauled in, *i. e.* a tide which runs against the wind. A "lee tide" is one running with the wind, and the bulter cannot be hauled in while such a combination of forces lasts. On this account much delay may be experienced.

Plymouth Bulters.—The Plymouth bulters use longer lines than any other boats on this portion of the coast, but the North Sea long-liners use much longer lines than they do here. A North Sea bulter may be 7200 fathoms long and carry as many as 4680 hooks (No. 11).

Lines.—The lines in use here are obtained from various places in Ireland and Scotland, and from London, as well as from local manufacturers. They are generally used in the same condition as they arrive, but they may be "barked" or "tarred." They are made of manilla or of sisal, an imitation of manilla.

Hooks.—The hooks are supplied from France or from Redditch.

Grounds Fished.—The grounds most frequented by the bulters with the longest lines are situated:

1. Far out in the Channel, from a point forty miles south of the Eddystone to a point twenty to thirty miles south of the Lizard.

2. Close to the land in the region of the Lizard and even round Land's End, and as far north as St. Ives.

3. Off Start Point, from fifteen to twenty miles south.

These boats also visit Guernsey, Brighton, and other places for a few weeks at a time to carry on their trade.

The smaller bulterers with shorter lines, shoot the latter all along the coast both west and east of Plymouth Sound, and round about the rocks of the Eddystone, the Hand

Deeps, and in places along the line of rocks extending from the Eddystone to Dodman Point, which I have already mentioned (p. 8) in my account of the trawling grounds in this neighbourhood.

The ground fished in mid-channel is composed of rubble, the stones being about half the size of a man's head, or thereabouts, and is locally known as "titi" ground.

The bulterers can shoot their lines upon this class of ground without fear of being disturbed by the trawlers, the ground being too rough for them.

Near home, where the exact positions of large rocks are known, and when the weather is clear enough to enable the fisherman accurately to take his marks, the lines are shot as near as possible to these rocks, and probably the finest fish are caught in these spots.

Fish Caught.—The following fish are those usually caught by this method of fishing:—Conger (*Conger vulgaris*), ling (*Molva vulgaris*), ray and skate (*Raia alba, circularis, batis,* and *clavata*), cod (*Gadus morrhua*) in small quantities, and a few pollack (*Gadus pollachius*).

Bait.—The bait used by bulterers is chiefly squid (*Loligo*); but they also use pilchard, mackerel, herring, garfish (*Belone vulgaris*), whiting (*Gadus merlangus*), gurnard (*Trigla*), chad (the young of *Pagellus centrodontus*), bream (*Cantharus lineatus*), and dogfish (*Scyllium canicula*); according to the season and in case of scarcity of squid.

During the spring—about Lent—when many trawlers are fishing in Mount's Bay, and there is but a small supply of squid and great competition for what there is to be sold, the bulterers fall back on "fish-baits," and pilchard is perhaps the best of these.

At this time of year the long-line fishermen even go as far as Falmouth, Mevagissey, Looe, and other ports along the coast to buy bait.

Price of Bait.—The price of bait varies very greatly. Squid, when very plentiful, may be as low as 6*d.* a maund, but during Lent has been known as much as 12*s.* a maund. Pilchard in the same way varies from 6*d.* to 5*s.* per 100.

Amount of Bait Used.—Some idea of the amount of bait

which might be used may be gathered from the fact that it takes 1000 pilchards or six maunds of squid to bait a long bulter. A maund of squid will weigh, say, 56 lbs.

Say sixty boats average 2000 fathoms of line, *i. e.* 1333 hooks per boat. They will consume 288 maunds of squid or say 144 cwt. (over seven tons) in baiting their lines.

Value of Bait Used.—

This amount represents in value at 6*d.* a maund .	.	£	7	4	0
„ „ 12*s.* „ .	.	172	16	0	

or, they will use 48,000 pilchards, which represents in money—

at 6*d.* per 100 .	.	£ 12	0	0
at 5*s.* „ .	.	120	0	0

In the case of a single boat. When squid are cheap it costs 3*s.* to bait a long bulter with 1666 hooks, when dear £3 12*s,* whereas pilchards cost from 5*s.* when cheap to 50*s.* in the dearest times, to bait a long bulter.

An average is not easy to calculate, but from the accounts of two hookers which have been very kindly submitted to me, it appears that about £100 a year per boat is spent on bait ; that is to say, bait for sixty boats of the same size for the year would cost £6000.

Making allowance for boats laid up at various times, the smaller size of some boats, and the fact that certain of them do not use their lines all the year round, the sum spent on bait for the year by Plymouth boats may be estimated at not less than £4500. The bait question is therefore a serious one.

Squid (*Loligo*).—The supply of squid depends, as I have stated, upon the trawlers. After a spell of rough weather the hookers having no bait must wait until the trawlers can go out and bring some, then if calms or storms should at once come on the bait spoils, and again when fine weather comes they have to wait until the trawlers have made a trip and brought in bait before they can go out to fish.

This obviously entails great loss of time and money, and renders the bait question one of extreme importance for the hooking trade of the port.

Attempts have been made to preserve squid in salt or ice but they do not appear in this condition to attract the more

valuable fish, conger. This fish, contrary to the general opinion, appears to be a very particular feeder. It will take into its mouth and bite, but as a rule ultimately reject, any but fresh bait.

Whelks (*Buccinum undatum*).—Whelks are not found here in abundance and do not occupy the important position among bulter baits here that they do among the North Sea cod fishermen. They are tough and make excellent bait for bulters. It must be recollected that, owing to the length of time the bulter is under water, quite a different kind of bait is required for this fishery to that required for the hand-line fishery. Mussels (*Mytilus edulis*), "queens" (*Pecten*), and such soft bait is only of use on hooks that are let down into the water and pulled up again in a few minutes; a prolonged immersion would render them too soft for the hook to hold them, and even a comparatively short time on a bulter-hook is enough to render them unattractive as bait.

Condition of Fishery.—With regard to the condition of the bulter fishery the men consider they do not catch as much fish now as they used to do twenty or even eight years ago, although their gear is eight times as long as it used to be, and the boats are larger, better, and more numerous. It is their opinion this is due to over-fishing, and as a proof of this they point out that very much smaller conger are exposed for sale on the Quay now than used to be the case. It is said that Plymouth is more deeply interested in this fishery than is any other port in the west country.

6. *Hand-line Fishing.**

Boats.—There are, say, 110 small boats, most of them under five tons, and 100 small rowing boats under one ton, engaged in this fishing.

As a rule they fish for particular kinds of fish, going to particular grounds for the various kinds of fish according to the time of year, tide, weather, and so forth.

Hand Lines, Bottom Fishing, Railing or Whiffing.—The

* Besides the information derived from practical fishermen included in this section of my report, I have freely used the publications of Bellamy (No. 33, *b*), Lord (No. 17), Young (No. 25), Wilcocks (No. 24), and Brooks (No. 5).

fishing is carried on by means of lines held in the hands and let down from the boat, in the case of bottom fishing when the boats are anchored; or held in the hand or fastened to rods which are fixed, in the case of "railing" or "whiffing," when the boat is sailed or rowed through the water. The latter method is used for fish which are feeding near the surface, as do the mackerel when the shoals have broken up.

Whiting Fishing (*Gadus merlangus*).—The most important hand-line fishery carried on here is the whiting fishery.

Season.—It commences about April, or may be earlier, and lasts until the end of the year.

Boats.—Between Christmas and April, many of the larger hand-line boats are laid up—(in Cawsand at the entrance to the Sound, which is almost altogether a whiting fishing village, nearly all the boats are laid up)—and the hands ship in hookers, or go fishing with crab pots in smaller boats. A few of the larger boats, however, fish for herrings with a few herring drift nets during these three months.

Ground.—The whiting ground may generally be said to be from seven to ten miles outside Plymouth; but these fish are caught anywhere from a point outside the Mewstone from which one can see well up Yealm Gut, to twenty miles away.

In spring the ground frequently taken lies south-east of the Eddystone; later on in the year the fish are to be caught north-east of the "Stone." Small whiting are very generally caught in the Sound.

Time of Year.—The fishery lasts from April to Christmas.

Bait.—The chief bait used is mussels (*Mytilus edulis*), lug-worms (*Arenicola piscatorum*), pilchards (*Clupea pilchardus*), mackerel (*Scomber scomber*), garfish (*Belone vulgaris*), and other kinds of fish, such as chad (young of *Pagellus centrodontus*).

Hake Fishing (*Merlucius vulgaris*).—Great numbers are taken with hook and line during the winter pilchard fishery, when these fish can be obtained readily for bait. It is a frequent occurrence for drift fishermen while their nets are out for pilchards to fish with hook and line for the hake which come in search of the pilchard. These fish feed, and therefore take the hook best, at night. They vary from 5 to 12 lbs.

Haddock Fishing (*Gadus æglefinus*).—When fishing for haddock with hand lines the best bait is squid with a large mussel on the point of the hook.

Cod Fishing (*Gadus morrhua*).—The codfish caught here are comparatively few, and they are not to be compared with the North Sea cod for either condition or flavour.

Bait.—The best bait to use is squid, mackerel, herring, or pilchard.

Pollack Fishing (*Gadus pollachius*).—*Ground in the Sound.*—The positions in the Sound and its neighbourhood where pollack are found are numerous.

1. On the east side all along the shore at a depth of about three fathoms, and round the Mewstone, especially off the "Mewstone," "Leek Beds" and "Batten Bay."

2. On the north side under the "Hoe," and between "Drake's Island" and the main land.

3. In the Hamoaze at the "Pollack Rocks."

4. On the west side all along the shore (except far in Cawsand Bay) and round Penlee Point, especially at Barn Pool, and off "the Bridge," Picklecombe Point, and Penlee Point.

5. On the south side from "the Tinkers" to the east end of the Breakwater. From the "Knap" Buoy round the west end of the Breakwater and along its south side.

Movements of the Fish.—The majority taken within the Breakwater are small fish; mature fish (2½ to 10 lbs.) are taken only at certain times. From spring to midsummer mature fish are taken off the Mewstone and the Tinkers, until the higher temperature drives the fish to deeper water, where they are caught in the offing; they visit the shallows only at intervals.

In September, the large fish return to the shallows and in autumn are caught especially in Barn Pool and between Drake's Island and Mill Bay in twenty-three fathoms of water. The largest fish caught in the harbour, are, as a rule, caught at night.

Bait.—The best bait for ground fishing is living sand-eels (*Ammodytes lanceolatus* and *tobianus*); the professional fisherman uses the rag-worm (*nereis*) generally. For whiffing artificial baits are used.

Rod and Line Fishing.—Pollack fishing is also carried on off the rocks, when rock-fish or sand-eels are used for bait, with a rod and line.

Time of Year.—Pollack fishing commences in May and continues throughout the fine weather.*

Mackerel Fishing (*Scomber scomber*).—*Ground.*—The best places for ground fishing are from Batten to Bovisand, and in the Hamoaze.

Bait.—The bait used with the greatest success is pilchard, squid, and mussels.

Whiffing.—The positions for mackerel "whiffing" are the same as those given on the map for pollack.

Railing.—"Railing" for mackerel is carried on in the summer. The boats are sailed about three miles an hour.

Bait.—The best bait appears to be some shining object, such as slips of tin or attractive pieces of cloth.

Bass Fishing (*Labrax lupus*).—*Rod and Line.*—Bass are fished for with rod and line off the rocks at Raeme Head, Penlee Point, Bottle-nose Point, and at either end of the Breakwater, by throwing out the line, to which is attached a spinning bait, and drawing it back along the surface.

Bottom Fishing, Bait.—Bottom fishing is carried on also for bass with squid or pilchard, or sand-eel for bait.

Times of Year.—Bass enter the harbours in summer. July is the best month for fishing, but they are caught up to the end of September. Outside the Sound the fishing off the rocks begins about May.

Whiffing.—Whiffing for bass is carried on over the same ground marked on the map, frequented by fishermen of pollack and mackerel.

Pouting Fishing (*Gadus luscus*).—*Time of Year.*—Pouting are in their best condition in November and December, but are taken all through the winter and in spring. The best places to fish for them are :

Grounds.—The Mallard Buoy, near Mount Batten at low water or on the flood tide. West Hoe Terrace during the

* For positions, see fishing map (p. 76). The dotted lines represent the best courses for whiffing, the crosses and stars the best places for ground fishing.

flood tide. Near the White Buoy, at the east end of Drake's Island, on the top of the flood tide. At Millbay Pier at low water. In a deep pit off the "Flat Rock." In Firestone Bay, on a flood tide. In Cawsand Bay, and off Bovisand Pier. Inside the Breakwater along its west half, and by the Panther Buoy.

Bait.—The baits generally used are sea-worms (*Arenicola piscatorum* and *Nereis*), mussels, and the "tail end" of the hermit crab (*Pagurus*).

Bream Fishing (*Pagellus centrodontus and bogaraveo*).—*Grounds.*—Bream are caught on the whiting grounds.

Bait.—The best baits are rag- or lug-worms, sand-eel, mackerel, pilchard, herring, mussel, or limpet (*Patella vulgata*).

Chad Fishing. (*Pagellus centrodontus*, Young Sea Bream.)—*Time of Year.*—Chad fishing begins in August.

"Float Line," and Bottom Fishing.—They are fished for when swimming near the surface with a "float line," and are fished for on the bottom also.

Grounds.—The grounds mostly frequented are: A short distance due south of the Round Fort at the Breakwater; at the "Knap Buoy," "Penlee Buoy," and "Shagstone."

Fish Caught by Hand Lines.—The fish caught by hand lines are therefore:—By bottom fishing:

Teleostei.—*Acanthopterygii*:

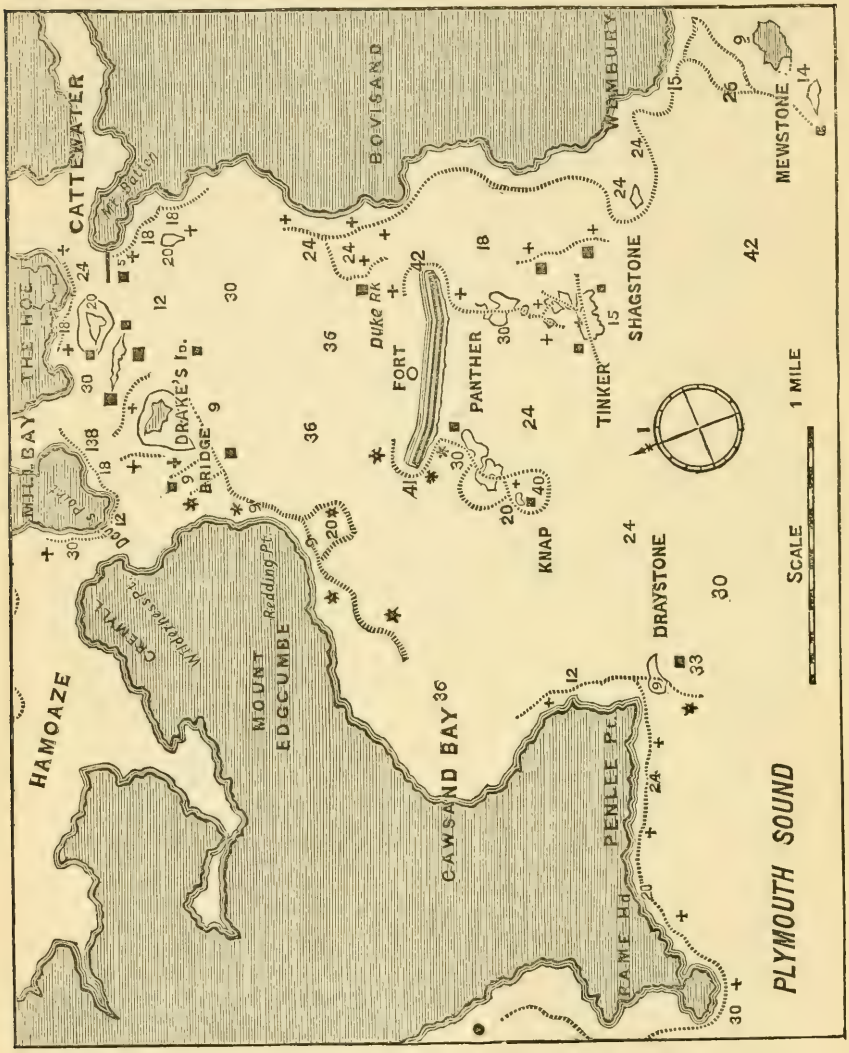
Scomber scomber . . .	Mackerel.
Cantharus lineatus . . .	Black bream.
Pagellus centrodontus . .	Common sea bream.
„ „ . . .	Chad (young).
„ bogaraveo . .	Spanish bream.
Labrax lupus	Bass.

Anacanthini:

Gadus morrhua . . .	Cod.
„ æglefinus . . .	Haddock.
„ pollachius . . .	Pollack.
„ merlangus . . .	Whiting.
„ luscus	Pouting.
Merlucius vulgaris . . .	Hake.

By whiffing: pollack, mackerel, and bass.

Fishing Map of Plymouth Sound, after map published in C. and R. Brooks's 'General Guide to Sea Fishing' (No. 5).



The depth is marked in feet thus 30. The best places to fish for pollock, bass and mackerel is shown by the dotted line. The crosses show places to fish in ebb tide, the stars show places to fish in flood tide.

Bait.—The baits used for hand lines are: Fresh squid (*Loligo*), which is supplied by trawlers, this is the best; dried squid and salted squid are also used, but with little success; mussels (*Mytilus edulis*), obtained by a limited number of mussel fishers from the bottoms of hulks, &c., from beds up the Hamoaze, and from off the stones of the Breakwater; "queens" (*Pecten*), supplied by the trawlers in large quantities in summer; mackerel (*Scomber scomber*), herring (*Clupea harengus*), and pilchard (*Clupea pilchardus*), obtained from drift fishermen; garfish (*Belone vulgaris*), obtained from drift fishermen generally; chad (*Pagellus centrodontus*), &c., fished for with hand lines; sand-launce or sand-eel (*Ammodytes lanceolatus* and *A. tobianus*), obtained by raking the sand at low water, or in some places by seining, an excellent bait; hermit crab (*Pagurus*), the soft part of the body of the animal is used; white sand-worms (*Nereis versicolor*), and rag-worms (*Nereis lineata ?*), two species of Nereis which are found in the mud of creeks, &c., at low water, the latter is the favourite worm bait; lug-worm (*Arenicola piscatorum*), found by digging in sand at low water; and the earthworm (*Lumbricus*).

For whiffing the following baits are used: Strips cut from the tail end of mackerel, herring, pilchard, garfish, chad, &c.; strips of the skin of bass, gurnard, ray, &c.; strips of salt pork; pieces of parchment, cloth, and tin; but the best bait of all is the sand-launce, which is put on the hook alive. Artificial baits are used, the best of these being an imitation sand-launce made of india rubber. This is mostly, if not exclusively, used by amateur fishermen.

Mussel Bait.—It is noticeable that mussels are not used to the same extent here as they are in the North Sea.

There is a very considerable industry connected with the supply of mussels for bait in the North Sea, and it is calculated (No. 8) that 1000 tons of mussels will catch £41,000 worth of haddock, cod, and whiting in the North Sea.

An apparatus (No. 9) for storing, keeping alive, and fattening molluscs has been patented, and mussel farms instituted in several places on the northern coasts of the kingdom, with, I understand, fair financial success. As

before observed, the method of fishing by means of long lines (bulters) is not favorable to the use of soft baits like mussels; but it would appear that, for hand-line fishing in this district, fish and worms are more extensively used for bait than mussels.

Pecten.—Pecten and mussels may perhaps be considered to be fairly equally in demand. The former is considered to be a very fragile bait, but there is a good supply of it.

Condition of Fishery.—The condition of this fishery is, as far as I can learn, good. Excellent and large fish are caught plentifully on the whiting ground, which is the chief fishery.

7. *Eel-spearing.*

Eel-spearing is carried on in the mud of the Tamar in the early part of the year.

The eels (*Anguilla vulgaris*) come down the river to spawn in the harbour about August, and they hibernate about Christmas in the mud of the estuaries. There are, however, eels in the harbour which do not migrate and do not hibernate, and they are reputed to be the best and finest tasted (No. 3 *a*).

8. *Mulletries.*

Some time ago several mill ponds communicating with the Hamoaze by means of gates were utilised as mulletries I am informed. The mullet (*Mugil capito*) were allowed to enter the ponds with the tide, and the gates were then closed and the fish caught with seines.

A pond, "The Mulletry," situated at Weston-Mill Lake, beyond Keyham, which is entirely cut off from the Hamoaze except by a sluice, has more recently been used for storing mullet; the fish being caught in the Hamoaze with a seine and placed in the pond until required for market.

Now, however, neither the mill ponds nor "The Mulletry" at Weston-Mill Lake are used commercially as fish ponds.

9. *Crab and Lobster Fishing.*

Ground.—Crab (*Cancer pagurus*) and lobster (*Homarus vulgaris*) fishing is carried on everywhere along the coast, mostly perhaps about Start Point. Off the Lizard there are one or two small steam launches engaged in this fishing.

Inside the Sound, and in deep water, up to thirty or forty fathoms, outside the Sound as well as along the neighbouring coast, the crab and lobster fishers of this port lay their pots.

Pots.—"Pots" only are used.

Bait.—The bait generally used is gurnard (*Trigla*), wrasse (*Labrus mixtus*), and ray, gurnard being the best for lobster.

Time of Year.—Summer is the chief time for this fishery. In the winter months there is but little done owing to the loss of pots in bad weather. Inside the Breakwater the fishery may be carried on from February to November, rarely in the intervening months. Outside the Breakwater, in deep water, the pots are laid only from about April to August.

The male crabs are about six times more valuable than the female crabs.

Condition of the Fishery.—The crabs are said to be decreasing, but lobsters are not thought to be decreasing as much as crabs.

From 1850, when there were eight boats fishing between the Plym and Bolt Tail there was a considerable increase in the fishery up to 1876, when there were 100 boats fishing this part of the coast. Since then there does not appear to have been much increase, if any. During this interval there has also been an increase in boats fishing in the Sound (No. 20).

10. *Shrimp and Prawn Fishing.*

Shrimps (*Crangon vulgaris*) and prawns (*Palæmon serratus*) are fished for in the Sound with small trawls, which are towed by small boats, either rowed or sailed slowly along.

The supply varies greatly according to the weather.

The chief ground is that lying immediately behind the Breakwater.

11. *Oyster, Mussel, and Cockle Fishing.*

Oysters (*Ostrea edulis*).—Very few oysters are now trawled in the Channel by the Plymouth trawlers. Sometimes, as I have already pointed out, a few clumps of oysters are brought up with the "scruff," which is so plentiful in the summer months.

Cattewater Beds.—Plym Beds.—There used to be oyster beds up the Cattewater, near Laira Bridge, up the

Plym, and in Cattewater Harbour, opposite Queen Anne Battery, they used to be abundant; there are, however, no beds now—a few isolated oysters may be picked up here and there. This failure of the Cattewater beds is, by some, attributed to over-dredging, but it would appear more probably to be due to the refuse from china-clay works pouring down the river and choking the beds.

It is said (No. 2) that the mineral sand and clay, which is so frequently brought down by the South Devon rivers, forms, with the chemical constituents of the sea water, a compound which destroys oysters. Scott states, speaking of the Devonshire oyster fisheries, that in 1864 there were practically no Devonshire oysters, and he considers this due to over-dredging (No. 22).

Tamar Beds.—Up the Tamar, at the mouth of the St. Germains River, there are, however, still oyster beds, though I cannot learn that they are in a flourishing condition.

In the Sound.—In the Sound, opposite West Hoe Terrace, at the foot of the Hoe, oysters are being laid down for storage, I am told.

Mussels (*Mytilus edulis*).—Mussels are plentifully obtained from the hulks lying in the Cattewater and the Hamoaze, and from the stones of the Breakwater. They are also dredged in large quantities in the lower reaches of the Hamoaze, and are then bedded on a bank near Saltash Bridge.

Cockle Beds (*Cardium edule*).—Cockle beds exist both up the River Plym, near Laira Bridge (to the north of it), and on a bank bare at low water, which lies in the centre of the Tamar river, some little distance north of Saltash. Only a very small trade is carried on in these shell-fish.

II.—Industries connected with the Fishing Trade carried on in Plymouth.

This subject may be subdivided into—

1. Boat building. 2. Sail making. 3. Rope making and fishing-line making. 4. Net breeding. 5. Fish curing. 6. Fish-skin curing. 7. Fish-oil manufacture. 8. Ice manufacture.

Boat Building.—The chief industry connected with the fish trade which is carried on in Plymouth is boat building;

sail making and rope making is also conducted here on a sufficient scale to supply the boat builders.

Nets.—Nets for drift fishing are not "bred" here, but the trawlers themselves make their own nets.

Lines.—Lines for hooking are made here, but fishermen do not exclusively rely on local manufacturers.

Fish Curing.—Fish curing is carried on, on a small scale only, and would, in my opinion, be well worthy of the attention of capitalists.

Fish Skins and Oil.—A small trade is also carried on in fish skins and fish oil, but these are at present on a very small scale.

Ice.—An ice manufactory exists.

1. *Boat Building.*

There are about fifteen boat builders in Plymouth and Devonport. Six of these build trawlers, three build drift boats, five build hookers, and several build rowing boats.

Trawlers.—Trawlers are built in Plymouth, chiefly for the Plymouth fishery, but boats have been built for the North Sea, and for other ports on the south coast besides Plymouth. Only a few, however, have been so disposed of, and none have been bought out of Plymouth for some few years. Trawlers have been obtained for the Plymouth fishery from Brixham and Galmpton, but, as may be seen from the Table on p. 38, only a few.

Trawler Measurements.—The following are the measurements of two recently built trawlers, and eight boats have been constructed of forty-two to forty-seven tons, with the same proportions.*

Measurements of.	Trawler Y.	Trawler Z.
Length	73·6 feet	70·4 feet
„ over all	81 „	...
„ load water line	70 „	...
Breadth extreme	16·75 „	17·5 „
Depth	9·65 „	9·4 „
Tons	49 tons	47 tons
Displacement	110 „	...

Cost.—The cost of such boats, including iron ballast spars, rigging, sails, and net, is from £750 to £1000.

* I am indebted to Mr. Watson (No. 34) for these measurements.

The following Table shows the number of trawlers built in Plymouth and other places since 1870 which are sailed from this port.

From this Table we learn that from 1870 to 1886 39 new trawlers have been sailed from Plymouth, and that of these 34 have been built in Plymouth, 3 in Brixham, and 2 in Galmpton.

Trawlers Built in	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882	1883.	1884.	1885.	1886.	Total.
Plymouth	1	5	...	...	...	...	1	3	5	5	5	2	3	1	2	...	1	34
Brixham	...	...	1	1	...	...	...	...	...	...	1	...	...	...	...	...	...	3
Galmpton	...	...	...	...	...	...	...	...	...	...	1	...	1	...	...	...	...	2
Total	1	5	1	1	...	...	1	3	5	5	7	2	4	1	2	...	1	39

Drift Boats.—Drift boats are chiefly built in Penzance and St. Ives; a few are built in Porthleven, and Looe, and three boat builders in Plymouth also build them.

Hookers.—Hooking boats are built here in five yards and are also obtained from St. Ives.

2. *Sail Making.*

Sail making is carried on, I understand, on a sufficient scale to supply the wants of the port. The sails, which are supplied to the fishermen *white,* are tanned by them in order to make them last the longer.

Trawlers tan their sails with a solution of bark. Drifters, on the other hand, tan the sails of their boats with a solution of catechu, the same as they use for their nets.

3. *Rope Making and Fishing-line Making.*

These industries are carried on in Plymouth. In the case of fishing lines, however, the fishermen use, besides those made by local manufacturers, lines obtained from Ireland, Scotland, and London. The lines are sometimes "tanned" or "barked" by the fishermen themselves for preservative reasons.

4. *Net Breeding.*

Trawl Nets.—Trawlers breed their own nets, and the method used by them for preserving the net has already been mentioned on p. 49.*

Drift Nets.—Drifters do not obtain their nets in Plymouth; particulars as to where the nets are made and how they are prepared by the fishermen here have already been given on p. 61.

5. *Fish Curing.*

Herring, Hake, Haddock.—Two or three small establishments are engaged in curing herring, hake, and haddock, but the business is only on a very small scale.

Pilchards.—A couple of establishments are concerned in the preservation of pilchards. Some few years ago pilchards were sent by rail and sea from Plymouth to be salted at St. Ives, Newlyn, and other Cornish ports. Now about half the pilchards landed here are cured on the spot.

* The cost of a trawl with spans and hawser is £51.

Pickling of Pilchards.—The new process of pickling the fish is carried on here. Pickled fish, although perhaps not so much liked as salted fish, keep very much longer and are more profitable property. Salted pilchards *must* be disposed of soon after curing, while pickled fish can be stocked. Fish will keep in brine seven or eight months without deteriorating.

The pickling process is as follows:—The fish are thrown into vats and covered with brine; if judiciously renewed the brine will preserve the fish until required, when they are packed in barrels and shipped. Considerable pressure, by means of screws, is applied during packing, and the bottoms of the barrels being perforated, the oil contained in the fish is pressed out and escapes into vessels placed below to receive it. Fish so treated are called in the trade pickled or marinated pilchards.

Salting Pilchards.—Pilchards are salted in the following manner:—They are placed in layers, a layer of fish and a layer of salt, until the heap rises three to five feet high; they are left thus "in bulk" as it is called, for, say, thirty days, during which the brine and oil drain from them into pits; they are then sifted free of the remaining dry salt, washed, and packed in casks under pressure (No. 10). Such fish are known as "fumados" or "fair-maids."

Export Trade in Pilchards.—About 5000 hogsheads of pilchards are exported from Plymouth per annum. There are about 3800 fish in a hogshead, and therefore about 19,000,000 fish are cured here,—a very small quantity in comparison to the number passing through the Cornish curing establishments (No. 6).

Pilchard Oil.—The pilchard oil is used by rope and varnish makers and for preparing leather and mixing with paint.

6. *Fish-skin Curing.*

Two small fish-skin curing establishments are in existence here, one of these being on an exceedingly small scale.

Skate and Ray Skin.—The skin of skate and ray is cleaned by a chemical process and dried; in this condition it is sent away to merchants in other parts of the kingdom.

The Trade.—How it is cleaned and to whom it is sent from here is known only to those concerned in the trade; while its ultimate destination and the purposes for which it is used is not known by those engaged in its preparation.

It is certainly used by brewers for "fining" beer, and that may be its only use.

7. *Fish-oil Manufacture.*

Fish Oil.—Besides pilchard oil, which has already (p. 84) been spoken of, oil is prepared from the livers of skate, ray, cod, and hake. The livers are boiled down and the oil collected.

Uses.—The oil is used for rope making and ship building, &c., while the refuse solid matter, which at one time was used for soap making, is now unsaleable. There is only a small business carried on here in this manufacture.

9. *Ice Manufacture.*

Ice is manufactured in an establishment on the Fish Quay —the Ice Manufacturing Company—by the ammonia process. Ice is also obtained from Norway, and stored here by the Ice Manufacturing Company, who have accommodation for 550 tons, and by an ice merchant.

III.—Methods of Ownership, Wage, Apprenticeship, Insurance, and Sale of Fish.

This section may be divided into—

1. Payment of trawlers. 2. Payment of drifters. 3. Payment of hookers. 4. Systems of payment compared. 5. The insurance of trawlers. 6. The insurance of drifters and hookers. 7. Methods of selling and buying fish.

Owners.—Smacks are frequently owned by several individuals, who, as shareholders in the vessel, are paid in proportion to the amount of money invested, out of the receipts of the fishing. Not a few are, however, owned by individuals who are generally boat builders, fishermen, or others connected with the fishing trade.

"Working out" Trawlers.—Trawlers are at times built without orders, as a speculation by the builder, and facilities offered to young and energetic fishermen to enable them to

become the owners of the vessel. The following method is usually adopted. A young man who is qualified, and is "second hand" on board some other boat, is offered the post of skipper on board the new vessel, and he undertakes to "work her out." He pays over year by year, out of his earnings, a proportion of the value of the vessel until a certain sum is in the hands of the builder, who then accepts a mortgage on the boat and the skipper becomes the owner and pays off the mortgage in instalments.

As will be seen in the following account, as skipper *and* owner he receives four and a half shares of the net proceeds of the catch.

Payments.—The men are paid on the share system, according to the value of the fish caught; the proportions of the shares varies, however, in the different kinds of fishing.

Insurance.—There are clubs for the insurance of trawlers, and of drifters and hookers managed entirely by the fishermen themselves in a very excellent fashion.

Fishermen.—The men who go fishing from this port are *bonâ fide* fishermen, they are not landsmen shipped during the fishing season and who work ashore during the rest of the year: such is the case with a great proportion of the crews of fishing boats on the Scotch coast during the herring season and on the east coast of England, but here the men are brought up to the fishing business and understand all the details connected with the craft as only such men can.

Boys.—The few apprentices who are shipped on board these boats are well treated, the boys generally engaged are sons or relations of the skipper, owner, or one or other member of the crew of the smack in which he sails, and they are paid by a proportionate share of the value of the catch.

A complaint of ill-treatment made by a boy is, I understand, unknown here, and the good feeling and kindness existing was very favorably commented on by the committee appointed in 1883 to inquire into these matters (No. 21). The fishermen bear a character for thorough honesty and kind-heartedness, which I myself have every reason to believe is not exaggerated.

1. *Payment of Trawlers.*

The crews, a skipper, two men and one boy, find their own food while on board the smack.

Trawl Fish.—The net value of the catch of trawled fish is divided into seven shares. Of this the owner or owners of the boat have three; the skipper one and a half; the second hand one; the third hand one; the boy a half.

Hook Fish.—In case fish is caught by hook and line on board the trawler, as may be the case if the boat is becalmed, the catch is divided into five shares. Of these the owner has one and a half; the skipper one; the second hand one; the third hand one; the boy a half.

Salvage.—In case of salvage, the sum received is divided into six shares. The owner has two and a half shares of the net amount of salvage paid; the skipper one; the second hand one; the third hand one; the boy a half.

Expenses.—All expenses connected with the boat and fishing gear, both renewals and repairs, are borne by the owner or owners of the vessel.

Stocker.—Besides these payments made to the crew there are certain perquisites the payment of which appears to be thoroughly understood, but which varies somewhat in different boats. The perquisites are locally known as "stocker." There are two kinds of stocker: (1) "men's stocker;" (2) "boy's stocker."

(1) *Men's Stocker.*—Men's stocker consists of thickbacks (*Solea variegata*), queens (*Pecten*), male crabs ("he crabs"), lobsters, and possibly other produce.

(2) *Boy's Stocker.*—Boy's stocker consists of squid (*Loligo*) and female crabs ("she crabs").

The men's stocker is divided into three shares: and of these the skipper has one; the second hand one; the third hand one.

The boy's stocker is divided into two shares; of which the third hand has one and the boy one.

The third hand has therefore a share of both men's and boy's stocker, but he may be paid about 2*s.* 6*d.* a week instead of receiving boy's stocker.

"*Pleasure Boy.*"—In case the trawler is a specially large vessel an extra hand may be employed, who is known as a "pleasure boy." He is paid wage by the owner and the crew, all joining in the payment; generally he is paid 2*s.* 6*d.* a week, and this sum is deducted from the net proceeds of the catch before it is divided into shares.

"*Extra Boy.*"—On the other hand, in case the skipper is an old man, he may take an "extra boy" to help him in his work; in this case the boy is paid by the skipper alone.

Apprentices.—There are but few apprentices in Plymouth. In 1884, when the "Fishery Boats Act" came into force, there were five apprentices; since that date only ten others have been bound. The apprentice lives with his master when on shore, and all food, &c., is found for him ashore and afloat. He is generally bound to serve until twenty-one years of age if he begins young, but if he is, say, eighteen years of age when he commences, a special arrangement is made as to the term he shall serve. An apprentice commences his service as "boy," but he may become third hand, or even second hand, before his term of service is over. The following are the payments made to him while he remains apprentice:

Payment of Apprentice.—While serving as boy he receives from his master 6*d.* a week, and has besides half share of the "boy's stocker." His master takes the half share of the catch belonging to the "boy," and half share of the "boy's stocker."

While serving as third hand he receives from his master 1*s.* a week, and has besides half share of boy's stocker, and one third share of men's stocker; he also has one quarter share of salvage in case there is any. His master takes the third hand's share of the catch, *i. e.* one share; also half a share of "boy's stocker," one sixth share of men's stocker, and three quarters share of salvage due to the third hand.

While serving as second hand he receives from his master 2*s.* a week, and has besides one third share of men's stocker, and one quarter share of salvage; his master taking the second hand's share of the catch, *i. e.* one share,

two thirds share of the second hand's stocker, and three quarters share of his salvage money.

Earnings of Apprentice.—The apprentice is obliged to deposit his earnings with the officer of the Mercantile Marine, and is allowed from these earnings, during the first and second year of his service, 1*s.* a week "spending money," and during the remainder of his term 2*s.* a week. This is all the money he is allowed to have. Naturally the boy does not make a full return of his earnings; if he did so, it is calculated that at the end of his term of apprenticeship he would have about £25 to £50 in the hands of the Mercantile Marine officer.

On completion of his term of apprenticeship to his master's satisfaction he receives three suits of clothes, one pair of boots, one great coat, and £1 1*s.**

2. *Payment of Drifters.*

Plymouth Drift Fishermen.—The value of the catch is divided into eleven shares. Of these the owner has five and a quarter; skipper, one and a quarter; second hand, one; third hand, one; fourth hand, one; fifth hand, one; boy, half.

The owner finds the boat and all the gear, and makes good all repairs and losses.

On account of the greater comparative value of the nets employed in drift fishing, the owner has a considerably greater proportion of the gross amount of the catch than the owner of a trawler is allowed.

Cornish Drift Fishermen.—With the Plymouth system it is interesting to compare the system of payment adopted by Cornish drift fishermen. The latter is, in fact, a co-operative system, and is probably directly derived from the most primitive co-operative method.

The owner of a boat forms an "adventure" for each fishing season. For instance, in the mackerel season, the owner gets together a crew for his boat, who undertake to man his boat for the season.

* I am indebted for most of this information to Mr. W. H. G. Deacon, the Superintendent of the Mercantile Marine Office in Plymouth (No. 31).

The "adventure" is divided into a number of shares, which vary in number according to the fishery prosecuted and the net-carrying power of the boat.

A mackerel boat of fifteen tons carries a skipper, six men, and a boy as crew.

In this case the adventure is divided into thirty-fourths, of which $\frac{x}{34}$ths = one share.

The owner who finds the boat and its gear and makes good damage, &c., sustained by it has . .	2 shares =	$\frac{4}{34}$ths.
The skipper who acts as ship's husband, and who makes a certain amount in that way has . . .	1 „	$\frac{2}{34}$ths.
The six men have *each* 1 share	6 „	$\frac{12}{34}$ths.
The boy	$\frac{1}{2}$ „	$\frac{1}{34}$th.
The nets	$7\frac{1}{2}$ „	$\frac{15}{34}$ths.
	17 shares =	$\frac{34}{34}$ths.

The nets are usually brought on board by the men engaged. One man may bring two nets, another one net, and so forth. The owners of the nets are paid in proportion to the number of nets they bring on board out of the sum ($\frac{15}{34}$ths) which is set apart for the nets. By this arrangement the undertaking has essentially the character of a co-operative society.

Cornwall is, I believe, the only county in England where this method is carried out by the fishermen.

The numbers of shares, as I have before said, in an adventure, vary according to the fishery and the net-carrying power of the boat, and this makes the agreements all the more complicated. There appears, nevertheless, to be an excellent understanding between the several parties who enter into these engagements every year, and a dispute is of very rare occurrence (No. 30).

3. *Payment of Hookers.*

Shares.—Among hookers the details are again different. The gross catch is divided into five and a half shares. The owner of the boat has one and a quarter shares; the skipper, one and a quarter; second hand, one; third hand, one; and fourth hand, one.

Until recently the owner took one and a half shares and

the skipper and three men one share each; now the owner divides his half-share with the skipper.

Men's Food.—The question of the men's food is treated differently on board hookers to what it is on trawlers. Any food which the crew may wish to have while fishing off the port they must find themselves; but if they go away to fish in other parts of the coast their food is considered as an expense attending the adventure, and its value is subtracted from the net proceeds of the trip before they are divided into shares. By this means the owner pays a proportion of the keep of the men while fishing away from home.

"*Stocker.*"—Perquisites are claimed by hookers in most cases; but the fish claimed for such "stocker" varies indefinitely, and the amount of it allowed for stocker differs according to the arrangements each owner may make with his crew. Some owners allow no stocker at all; others allow the skipper to sell a small "lot" of fish on his own account, or on account of the crew. As a general rule it may be said that if a few ling or pollack, two or three hake or conger only are caught during one day's fishing, this small lot may be disposed of by the skipper.

No particular fish is, as a rule, considered by hookers as their perquisite.

4. *Systems of Payment Compared.*

The method of paying fishermen entirely by poroportions of the proceeds of the catch of fish is, I am informed, universal in Cornwall and Devon, and, according to Professor Leone Levi (No. 16) is also in use in East Coast fishing ports.

Another system is, however, practised, at any rate in some of the latter ports (No. 23). According to this method, the owner pays a certain wage to the skipper and men, who receive besides, a share of the value of the catch.

In the Scotch herring fishery ports, the skipper is paid according to the catch, and the men paid wage. This was the case at Grimsby in 1877 in certain cases (No. 17 *b*), and in the North Sea Cod Fisheries a similar practice prevails now (No. 4).

There are therefore three systems of payment in use among fishermen.

1. Payment by share. (A) When men are paid for work only (Plymouth trawlers). (B) When men are paid not only for work done but for fishing material supplied (Cornish drift fishers).

2. Payment by wage.

3. Payment partly by wage and partly by share.

As far as the greater number of men are concerned this latter method would appear most advantageous, viz. that they should have a small fixed income under all circumstances. They would thus be enabled to live when the trade is very unremunerative, but they would be stimulated to work hard in order to increase their income by sharing in the proceeds of the fishery as well.

Improvidence, Poverty.—There would appear to be a considerable number of fishermen in the port who do not recognise the importance of laying by money during good times, and in consequence of the irregular nature of the trade in which they are concerned and the enormous fluctuations in the price of fish, there are without doubt a large number of cases of poverty and distress amongst them during bad seasons.

In spite of this, however, the system of payment by share only, in use here, is considered by the better fishermen themselves, and by others who take an interest in the welfare of these men, to be by far the best system of payment, and calculated at any rate to make men independent, careful of money, hard workers, and watchful, shrewd fishermen.

5. *The Insurance of Trawlers.*

Mutual Insurance.—There is a mutual insurance club for trawling vessels, composed of the owners of vessels, and managed by a president and committee elected once a year from amongst themselves.

Rates.—The club insures for total loss only, the policy being limited to £300, for which there is an annual subscription of £1.

For a 1st class trawler (a new boat and until 10 years old) the policy is for	£300
For a 2nd class trawler (from 10 to 15 years old) . . .	250
For a 3rd class trawler (from 15 to 20 years old) . . .	200

and there may be a further reduction for a boat more than twenty years old.

The exact times when the club determines to reduce its liability on any vessel, depends upon the committee of the club, who examine the vessels from time to time and class them in accordance with their age and condition.

Brixham.—At Brixham the trawlers can insure for total and for partial loss.

6. *The Insurance of Drifters and Hookers.*

Insurance.—The insurance of these boats is on a much smaller scale. The maximum amount of a policy is £60, and the subscription 15*s.* a year. The club is managed in the same way as the trawlers' insurance club, the committee having power to determine the value of the policy any boat may take out. The maximum amount for which these boats may be insured is so small that several owners of the best boats will not insure their vessels.

The club, however, is in a flourishing condition.

7. *Methods of Selling and Buying Fish.*

Auction.—Fishermen place their catch in the hands of fish salesmen, who sell it, by auction, either to fish hawkers, local fishmongers, or fish buyers for London and other markets.

The auctions are of two kinds; either the lot is handed over to the highest bidder as in ordinary auction transactions; *or*, the lot to be sold is put up at a fancy price, the auctioneer reducing it until he reaches a figure which is accepted. This latter method is called "Dutch auction" and is very general on the east coast.

Commission.—The fish salesman charges 5 per cent. commission and guarantees the debt to the fishermen.

Discount.—All buyers of fish of a value of 20*s.* or more are allowed a discount of 2½ per cent. by the salesman, who thus makes 2½ per cent. on the amount he sells.

Trawl Fish.—Trawl fish is sold as follows :—"Head" or "prime fish" is sold by the catch in lots, except hake, which is sold by the dozen. "Offal" or "seconds" is sold by the maund*, skate and ray by the "lot," which may be any number.

Drift Fish.—Drift fish is sold :—Pilchards, per 126; herrings, per 126; mackerel, per 120.

Hook Fish.—Hook fish is sold :—Congers, per cwt.; ling, per dozen; skate and ray, per "lot" of any number; whiting, per dozen; pollack, per dozen; turbot, per fish.

List of Publications referred to.

No. 1. *Ansell.*—"On Trawling" ('Literature of International Fishery Exhibition,' 1883).

„ 2. *Anson and Willett.*—"Oyster Culture" ('Lit. of Int. Fish. Exhib.,' 1883).

„ 3*a*. *Bellamy.*—'The Natural History of South Devon' (1839).

„ 3*b*. *Bellamy.*—'Guide to the Fish Market' (1862).

„ 4. *Bertram.*—"The Unappreciated Fisher Folk" ('Lit. of Int. Fish. Exhib.,' 1883).

„ 5. *Brooks.*—'General Guide to Sea Fishing.'

„ 6. *Cornish.*—"Mackerel and Pilchard Fisheries" ('Lit. of Int. Fish. Exhib.,' 1883).

„ 7. *Edinburgh, H.R.H. the Duke of.*—"The Sea Fisheries and Fishing Population of the United Kingdom" ('Lit. of Int. Fish. Exhib.,' 1883.

„ 8. *Harding.*—"Molluscs, Mussels, Whelks, &c., used for Food or Bait" ('Lit. of Int. Fish. Exhib.,' 1883).

„ 9. *Harding.*—'Specification No. 15,891." Apparatus for Storing, Keeping Alive, Fattening and Protecting from the Force of the Sea, Edible Molluscs.

„ 10. *Houghton.*—"Natural History of Commercial Sea Fishes" ('Lit. of Int. Exhib.,' 1883).

„ 11. *Holdsworth.*—'Sea Fisheries,' 1877.

„ 12. *Holdsworth.*—"Apparatus for Fishing" ('Lit. of Int. Fish. Exhib.,' 1883).

„ 13. *Hunt.*—"Notes on Torbay" ('Transactions of the Devon Assoc.,' 1878).

„ 14. *Inglis.*—"Plymouth Sound—its Tidal Currents" ('Trans. of the Plymouth Instit.,' 1877).

* The weight of a maund of flatfish is, say, 70 lbs.; of round fish, say, 6 lbs.

No. 15. *Inglis.*—"Harbour Accommodation in the West" ('Trans. of the Plymouth Instit.,' 1885).
,, 16. *Levi, Prof.*—"Economic Condition of Fishermen" ('Lit. of Int. Fish. Exhib.,' 1883).
,, 17. *Lord.*—'Sea Fish and How to Catch them' (1862).
,, 17*b*. *Lundie.*—'Statistics of Sea Fishery at Great Grimsby" (1877).
,, 18. 'Report of Select Committee on the British Channel Fisheries' (1833).
,, 19. 'Report of the Commissioners appointed to Inquire into the Sea Fisheries of the United Kingdom' (1866).
,, 20. 'Report on Crab and Lobster Fisheries of England and Wales, Scotland and Ireland' (1877).
,, 21. 'Report of the Committee appointed under a minute of the Board of Trade to Inquire into, &c., Relations between Owners, Masters, and Crews of Fishing Vessels, &c.' (1883).
,, 22. *Scott.*—"The Fisheries of Devonshire" ('Trans. of the Devon Assoc.,' 1864).
,, 23. "Systems of Wage of the North Sea Fishermen" ('Fish Trades Gazette,' No. 165, 1886).
,, 24. *Wilcocks.*—'The Sea Fisherman' (1884).
,, 25. *Young.*—'Sea Fishing as a Sport' (1865).
,, 25*b*. 'Board of Trade Journal.'

I am, moreover, especially indebted to the following gentlemen for information contained in these notes:

No. 26. *Captain Bate* (Fisherman).
,, 27. *Mr. R. Bunt* (Fisherman).
,, 28. *Mr. R. Cload* (Fisherman).
,, 29. *Mr. G. Coles* (Fish Salesman).
,, 30. *Thos. Cornish, Esq.* (Letters to W. F. Collier, Esq.).
,, 31. *W. H. G. Deacon, Esq.* (Superintendent of the Mercantile Marine Office, Plymouth).
,, 32. *Mr. Johns* (Fisherman).
,, 33. *Captain Short* (Sutton Harbour Master).
,, 34. *H. B. Watson, Esq.* (Ship Builder).

To *Mr. Coles* my best thanks are due for a very large proportion of the facts included in Part I.

Description of the Laboratory of the Marine Biological Association at Plymouth.

By

Walter Heape, M.A.

The Laboratory which is now in the course of erection at Plymouth for the Marine Biological Association, is situated between the south wall of the "Citadel" and the Sound, at a height of 95 feet above the level of the sea. The site, which has been granted to the Association by the War Office, occupies the whole length of King Charles's Curtain, 265 feet, and extends southwards from the Citadel wall 240 ft., giving a surface of, say, 63,600 feet.

A road lies between this plot of land and the sea, and private access to a small section of the seaboard is provided for by means of a tunnel 7 ft. 6 in. high and 6 ft. 6 in. wide, which leads from the area surrounding the cellars, beneath the road, to the rocks below.

The building (*vide* Frontispiece) is placed 90 feet from the wall of the Citadel, and is about 60 yards from high-water mark. It is in the form of two blocks, which are each 34 ft. 6 in. long by 42 ft. wide and three stories high (40 ft.), and a central connecting portion 70 ft. long by 34 ft. 6 in. broad and two stories high (30 ft.). The east, south, and west fronts are built entirely of dressed limestone, which has been excavated on the spot; but on the north front the window- and door-dressings are of brick.

The roof of the central portion is peaked and covered with slate; that of the two blocks is flat and covered with lead.

Below the western block cellars have been excavated (Plate III) 14 ft. deep, surrounded by an area 6 ft. 6 in. wide

on the north and 4 ft. wide on the west and south sides; further the excavation has been extended between the cellars and the Citadel wall to form two reservoirs for salt water, each 37 ft. 6 in. long, 21 ft. 6 in. wide, and 13 ft. deep, and each capable of holding 50,000 gallons. The roof of a portion of each of the reservoirs (Plate I, *r*) is 6 ft. higher than the remainder and is fitted with a gangway (*t*) to enable a man to walk inside. These reservoirs are built of concrete and coated with a special asphalte supplied by Messrs. Leete, Edwards, and Norman, of London; they are arched in with brick and completely covered over.

The arrangement of rooms in the building is as follows:

Cellars.—The cellars (Plate III) are 13 ft. high, and consist of an engine room, 20 ft. by 16 ft.; a boiler room, 20 ft. by 11 ft.; an engineer's room, 13 ft. by 11 ft.; a coal cellar, store room, and w. c. Access to the cellars is provided for by means of steps down into the area on the north side.

Ground Floor, West Block.—The rooms on the ground floor (Plate I) are 12 ft. high. The main entrance to the building is in the centre of the west face of this block, and leads, on the one hand, by means of a straight passage 6 ft. wide direct into the aquarium, and, on the other hand, by means of a staircase 9 ft. wide to the first floor. A urinal is placed leading from the landing of this staircase. On the south side of the entrance are two rooms to serve as kitchen and bedroom for the caretaker of the building; these rooms are each 14 ft. by 12 ft., and between them is a pantry 9 ft. by 6 ft. On the north side of the entrance the scullery and offices for the caretaker, the staircase leading to the first floor, and a "Receiving Room" 20 ft. 6 in. by 16 ft. are placed.

Centre.—The central part is occupied by the aquarium from the east end of which a door leads into the

East Block.—On the north side of this block is Laboratory II, 17 ft. 6 in. by 16 ft.; on the south side Laboratory III, 15 ft. by 9 ft. The remainder of this floor of the block is occupied by the kitchen and offices of the Superintendent's residence. The main entrance to the residence

is in the centre of the east face of the block, it leads into a passage from which direct communication with the aquarium is provided. A staircase 7 feet wide leads to the first floor. A back door is placed on the north side.

First Floor, West Block.—The rooms on this floor (Plate II) are 11 ft. high. The staircase opens onto a landing above the entrance hall, and from this point a staircase communicates with the second floor, and a passage 6 ft. wide leads into the main laboratory. On the north side of this passage is the Physiological Laboratory, 20 ft. 6 in. by 16 ft.; on the south side the Chemical Laboratory, 22 ft. by 14 ft., and a small room communicating with the latter, 8 ft. by 14 ft., which is designed to serve as a photographic room. These two laboratories are entered through doors which open into the passage. At the end of the passage a door leads into the

Centre.—The main laboratory occupies the whole of the first floor of this portion of the building. It is provided with seven large windows on each side, which reach from a point 2 ft. 6 in. from the floor to a height of 10 ft. from the floor. The roof is a collar-beam roof with tie-rods leading down to the feet of the principals. It is 16 ft. from the floor to the ceiling along the centre of the room. The floor is especially constructed of Dennett's arching to ensure freedom from vibration as much as possible.

East Block.—The rooms on this floor are a dining room, pantry, and study for the Superintendent, and an office from which a door leads directly into the main laboratory.

Second Floor, West Block.—The rooms on this floor (Plate IV) are 10 ft. high. The staircase and passage are the same as on the first floor. On the north side of the passage is a lavatory, 16 ft. by 8 ft., for the convenience of workers in the laboratory, and a private workroom, 16 ft. by 12 ft., while the whole of the south side is occupied by the library, a room 30 ft. 6 in. long and 16 ft. wide.

East Block.—This floor is occupied by bedroom accommodation, &c., for the Superintendent and his servant. A small staircase 2 ft. wide will lead from the second floor on to the flat roofs of each block.

Fittings.

The Tank-room.—The tank-room is fitted with tanks of slate and of glass fitted in cast-iron frames, and water is supplied to these tanks through vulcanite piping. The system it is proposed to use for keeping the sea-water in good condition is known as the "circulating system." It was introduced into England by Mr. Lloyd, and is in use at the Crystal Palace and, I believe, all the inland aquariums. The Naples Zoological Station and various continental aquariums have also adopted this method of keeping the water continually in a satisfactory condition.

The system is briefly as follows :—By means of pumps the water is forced from the reservoirs through vulcanite pipes into the tanks. The pipes are placed about 2 feet above the level of the water in the tanks, and the water is forced through nozzles, the bore of which is from, say, one eighth to one quarter inch diameter, and regulated with a tap. Jets of water are thus forced into the tanks from some little distance above, and air in a state of very fine division is carried by the jet deep into the water of the tank, and distributed through it. By this means all decomposing organic matter is oxidised and the water constantly kept in a condition satisfactory for maintaining life. The force of the jet of water is regulated by the speed of the pumps and by valves placed in the main pipes, according to the amount of aeration required. The water overflows from the tanks into so-called "circulating reservoirs," which are placed below them but above the level of the water in the main reservoirs, and through these it is conducted to a culvert (Plate I, *p*) which conveys it back again to the main reservoirs, to be again pumped up into the tanks.

This is not the place to enter into a discussion of the relative value of the various methods now in use for keeping aquaria in good condition, but I would point out that the advantage of the method adopted by the Association is that the water is kept *constantly* in good condition.

A series of nine tanks are placed along the whole length

of the south wall of the aquarium. They are all 4 ft. wide and 4 ft. deep. One of them (*k*) is 15 ft. long, two (*l l*) are 10 ft. long, and the remaining six (*j*) are 5 ft. long. The circulating reservoir below this row of tanks is 2 ft. 6 in. wide and 3 ft. 6 in. deep. The circulating reservoirs are built of concrete and brickwork, and the internal surface covered with a special asphalte. The tanks are supported on the walls of the circulating reservoirs; each tank is provided with an overflow into the circulating reservoir and an overflow into the tank next to it, the level of the tanks being so arranged that the water flows from east to west. These overflows are so arranged that they can be used or not as desired, and thus any tank can be isolated.

A second series of three tanks is placed along the north wall. Two of them are 5 ft. deep and 9 ft. wide, one of these (*f*) being 15 ft. 6 in. long, the other (*g*) 30 ft. 6 in. long, while the third (*h*) is 5 ft. deep, 5 ft. wide, and 15 ft. long. The circulating reservoirs below are 3 ft. 6 in. deep and 7 ft. wide. The overflows are arranged like those on the south side. The height of the top of these tanks from the floor is 7 ft., while on the south side the top of the tanks is 6 ft. 6 in. above the floor level.

A third series (*e*) of five "table tanks," each 9 ft. 9 in. long, 2 ft. 3 in. wide, and 1 ft. 9 in. deep, is placed down the centre of the room. They are supported upon the walls of a circulating reservoir 1 ft. wide and 3 ft. deep, and being only 4 ft. above the floor level their contents can be examined from above.

The water in each of the circulating reservoirs flows at the west end into a culvert (*p*) which conducts it back to the main reservoir; the culvert is of concrete, lined with asphalte, and covered over with slate.

It will be convenient to include in this description of the aquarium a series of twelve small tanks, which are placed in a double row in the main laboratory (Plate II, *k*). They are supplied by the pumps with water, which flows again into the main reservoir. Each of these tanks is 1 ft. 6 in. deep, 2 ft. 3 in. wide, and 5 ft. long. The pipes are of vulcanite. A supply of water is also conducted through pipes

of the same material to Laboratories II and III, to the Physiological (Plate II), Laboratory, and to the "Receiving Room (Plate I)."

The Engine Room.—The engine room (Plate III) contains two patent "Otto" gas engines, one of two horse power (*b*), and the other of four horse power (*a*); two patent rotary pumps ("Forbes and Edward") in duplicate, each capable of circulating 7500 gallons an hour (*d*), and two similar pumps capable of circulating 2000 gallons per hour (*e*). These pumps are of vulcanite, and all the pipes, cocks, taps, &c., concerned with the circulation of the sea water are also of vulcanite. Vulcanite and rubber hose is used to convey the water from the reservoirs to the pumps. The two large pumps supply the tanks in the aquarium, the two smaller pumps the tanks in the Laboratory. In consequence of the necessity to circulate the water continuously, the engines and pumps have been supplied in duplicate.

For the renewal of water in the reservoirs a Shone's ejector placed at low-water mark has been provided. This ejector is supplied with compressed air from a receiver in connection with a compressor attached to the four-horse power engine in the basement of the building. This engine will thus perform as required the double function of circulating the water through the pipes and tanks of the aquarium and laboratory, or renewing the supply of salt water in the main reservoir from the sea. By this arrangement the necessity for a distinct pumping engine and house on the rocks, here exposed to the waves, is avoided.

The engine room also contains a special receiver for compressed air (*c*), which is distributed to the main laboratory in pipes for the purpose of aerating small aquaria containing minute organisms.

Receiving Room.—Materials for workers in the laboratory and to stock the aquarium will be brought by the fishermen into the "Receiving Room" (Plate I). This room is on the ground floor in the western block above the engine room, and communicates directly by means of doors with the yard outside and with the aquarium, and, by means of a lift, with the floors above it. The room is fitted with a

large sink (*a*), with tables upon which the sorting of material and the dissection of large animals can be carried on (*b*, *b*, *c*) —one of these tables (*c*) is supplied with a slate top—and with sufficient shelves (*d*). A supply of fresh and salt water, and a coil for heating water, is placed over the sink.

The room is lighted with a pendant in the centre, having two burners, and with brackets on the walls.

Main Laboratory.—Along each side of the main laboratory are seven compartments (*m*)—each 10 ft. long and 8 ft. wide—formed of wooden partitions on either side, 7 ft. high, and by a curtain suspended on a rod behind. Each of these compartments is fitted along the window with a bench (*o*) 9 ft. long, 4ft. 3 in. wide, and 2 ft. 6 in. high, and an earthenware sink (*n*) 1 ft. square and 8 inches deep. On the one side is placed a chest of drawers and cupboards (*r*), 4 ft. 6 in. long, 3 ft. high, and 1 ft. 8 in. deep, and the whole of the other side is occupied with a set of shelves (*p*) conveniently arranged to hold small and large bottles. The sink is supplied with fresh water; gas nozzles are conveniently placed on the bench, and a gas bracket on the central pier of the window-frame. Between these compartments on either side of the laboratory is a space 14 ft. wide. The eastern portion of this space is occupied with the series of twelve small tanks (*k*) already mentioned in the description of the aquarium fittings. They occupy a space 4 ft. 6 in. wide and about 30 ft. long. In a line with these tanks is a slate-topped table (*j*), 14 ft. long and 5 ft. 8 in. wide, along the centre of which is a partition 2 ft. high supporting a shelf. Water and gas taps are placed at intervals along the table. A large sink, 5 ft. long and 2 ft. wide is placed at one end of this table, and another sink, supplied with drying board, hot-water coil, &c., is fixed along the western wall of the room (*l*, *l*). A cupboard 3 ft. high is placed beside this latter sink and shelves above the cupboard.

Besides the gas brackets in each compartment, and one above the sink just mentioned, the room is lighted by three double-burner pendants hanging at intervals down the centre of the room.

The Chemical Laboratory.—A bench runs along the

windows 3 ft. 3 in. above the floor and 3 ft. wide (Plate II, *e*). Four stoneware basins are let into the bench at intervals, and fresh water conducted to each. Shelves are placed against the window-piers above the bench, and cupboards and drawers along its whole length beneath.

A slate-topped table, 8 ft. long, 3 ft. wide, and 3 ft. 6 in. high, is placed in the middle of the room (*d*), and contains four rows of drawers of different sizes, each row consisting of five drawers. A sink, 6 ft. long, with drying-board, table, and shelves, occupies the east wall of the room (*c*); shelves are placed along the north wall (*h*), and a stink-cupboard (*g*) and blow-pipe table (*f*) alone the west wall.

The room is lighted by a central pendant and by brackets on the window-piers, and gas nozzles for india-rubber tubing occur at intervals along the main bench, on the pendant above the central table, in the stink cupboard, &c.

The Physiological Laboratory.—There are two sinks in this room, each 3 ft. by 1 ft. 6 in.; one of these is of glazed earthenware, and is supplied with salt as well as with fresh water, the other is of wood lined with lead (*a*, *a*). A large cupboard, 8 ft. 8 in. long, 6 ft. high, and 15 in. deep, with air-tight glass doors, is fitted against the south wall (*b*) and shelves on the east wall. Two substantial tables, 6 ft. by 3 ft. and 3 ft. high, and one table, 6 ft. by 4 ft. and 3 ft. 3 in. high, are also supplied; these tables are not fixtures, but can be moved about as desired.

The gas supply is similar to the chemical room.

The Library.—The library, on the second floor of the west block, is fitted with shelves along the east, west, and north walls (Plate IV, *a*), and supplied with writing-tables and chairs.

Laboratories II and III.—Gas and salt-water and fresh-water pipes are carried into these rooms, but the fittings have been deferred for the present (Plate I).

Heating.—The greater part of the building is heated by means of air, which is passed over pipes through which hot water circulates at a low pressure. A boiler is fixed in the cellars and pipes are carried from it into the Receiving Room, along the north and south walls of the laboratory,

into the Chemical and Physiological Laboratories, the library and the Superintendent's office and living rooms. These pipes are cased in, fresh air is admitted within the casing through perforated bricks, and is distributed into the rooms through short vertical shafts placed against the wall at intervals. The top of each shaft is provided with a valve which can be regulated as desired and through it the warm air enters the room. The aquarium is warmed by means of hot-water pipes lying in a trench covered with iron grating along the passages between the three rows of tanks (Plate I, *a*).

Ventilation is provided for by means of shafts in the walls dividing the central portion from the two end blocks, into which the foul air from the top of the rooms is conducted through grids. The up-draught in these shafts may be assisted by means of gas burners placed within them. Ventilation in the main laboratory is assisted by means of revolving ventilators (Plate IV, *e*) placed in the roof.

CORRESPONDENCE AND SHORT NOTES.

Communications addressed to the Honorary Secretary of the Association will, if suitable, in future numbers of the Journal be published under this heading.

OFFICIAL NOTICES.

The Council has appointed Mr. J. T. Cunningham, M.A., F.R.S.E., Fellow of University College, Oxford, to the post of Naturalist at the Plymouth Laboratory. There were four applications for the post. Mr. Cunningham has for several years acted as Superintendent of the Scottish Marine Station on the Firth of Forth, under the direction of Mr. John Murray, of the "Challenger" Expedition.

DESCRIPTION OF PLATES I, II, III, IV.

Plate I.—Ground Plan.

a. Sink in Receiving Room.
b b. Tables.
c. Slate-topped table.
d. Shelves.
e. Five table tanks, each 9 ft. 9 in. long, 2 ft. 3 in. wide, 1 ft. 9 in. deep.
f. Tank, 15 ft. 6 in. long, 9 ft. wide, 5 ft. deep.
g. Tank, 30 ft. 6 in. long, 9 ft. wide, 5 ft. deep.
h. Tank, 15 ft. long, 5 ft. wide, 5 ft. deep.
j. Six tanks, each 5 ft. long, 4 ft. wide, 4 ft. deep.
k. Tank, 15 ft. long, 4 ft. wide, 4 feet deep.
l. Two tanks, each 10 ft. long, 4 ft. wide, 4 ft. deep.
m. Pillars to support Dennett's arching.
n. Manhole into circulating reservoirs along north side.
o. Trench covered with grating containing hot-water pipes.
p. Culvert conveying salt water from circulating to main reservoirs.
r. Raised portion of reservoirs.

Plate II.—First Floor Plan.

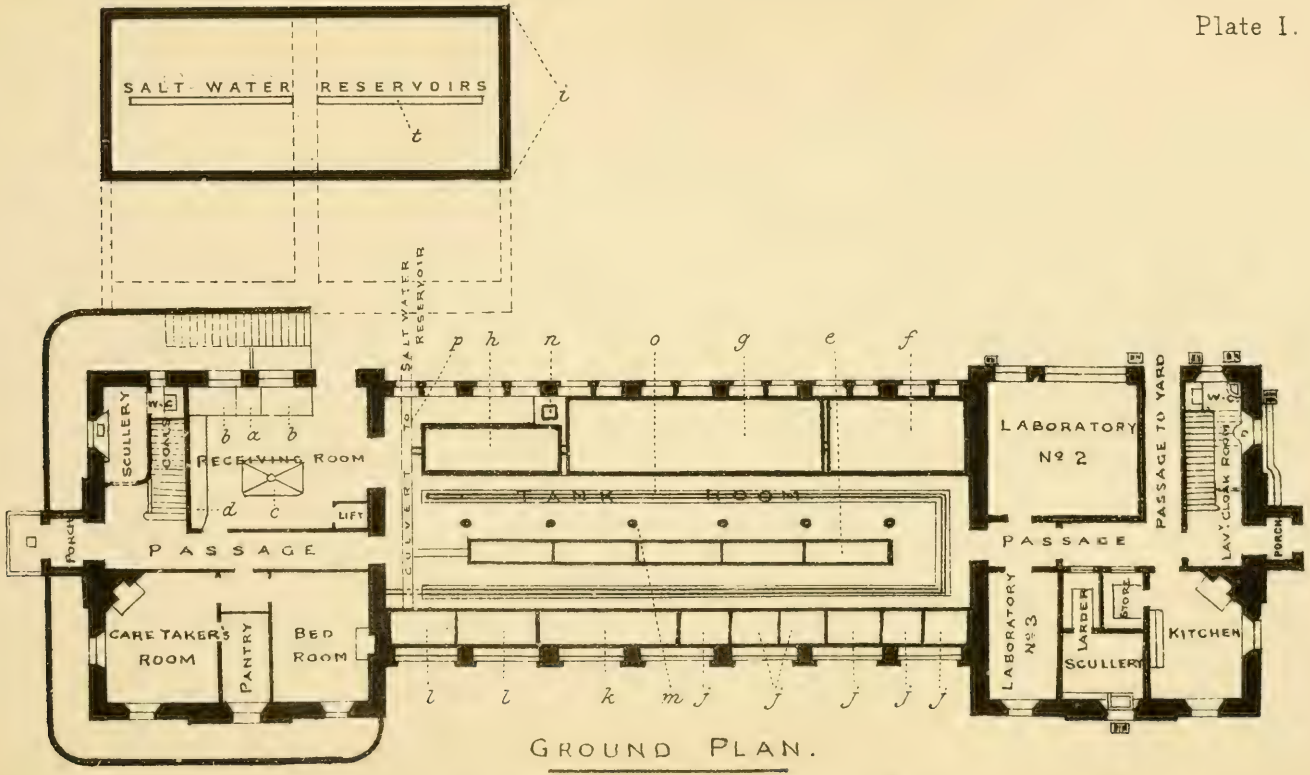
a a. Two sinks in Physiological Laboratory.
b. Cupboard with air-tight glass doors.
c. Sink in Chemical Laboratory.
d. Slate-topped table.
e. Bench.
f. Blowpipe table.
g. Stink cupboard.
h. Shelves.
j. Slate-topped table in main Laboratory.
k. Twelve tanks, each 1 ft. 6 in. deep, 2 ft. 3 in. wide, 5 ft. long.
l l. Two sinks.
m. A "compartment."
n. Sink.
o. Bench.
p. Shelves.
r. Table with drawers and cupboards.

PLATE III.—PLAN OF CELLARS AND FOUNDATIONS.

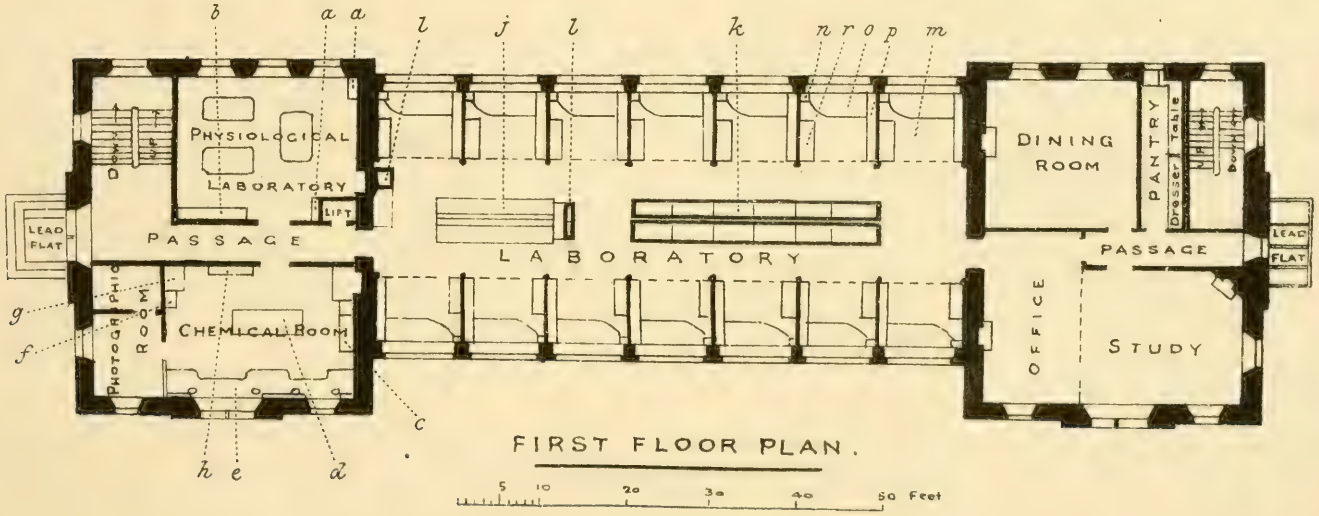
a. Four-horse power gas-engine.
b. Two-horse power gas-engine.
c. Compressed-air receiver.
d. Duplicate pumps to throw 7500 gallons an hour.
e. Duplicate pumps to throw 2000 gallons an hour.
f. Arching, in plan.
g. Drains.
h. Foundation for pillars to support Dennett's arching.

PLATE IV.—SECOND FLOOR PLAN.

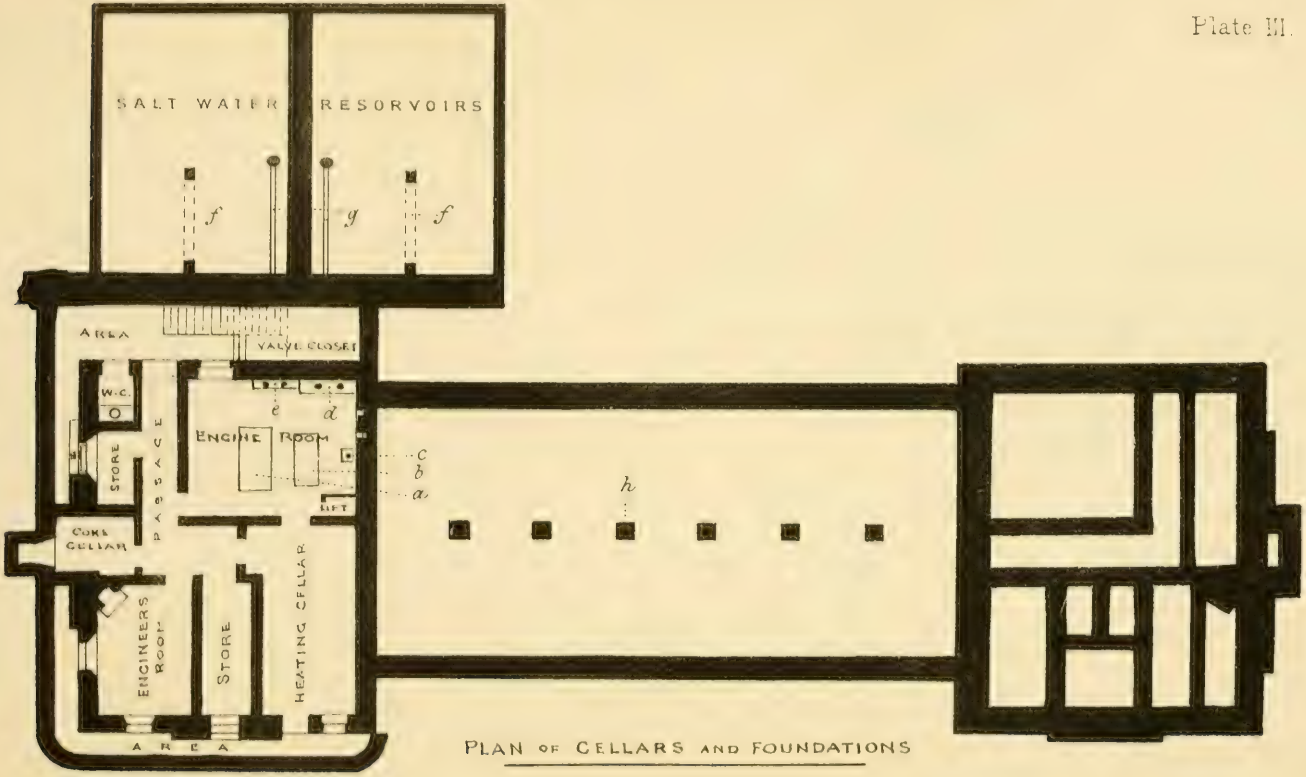
aaaa. Shelves in Library.
b. Washhand basins in Lavatory.
c. W.C.
d. Urinals.
eee. Revolving ventilators.


SALT WATER RESERVOIRS
t
i
SALT WATER RESERVOIR
CULVERT TO
p h n o g e f
SCULLERY
W.C.
CONS
b a b
RECEIVING ROOM
d c
LIFT
PORCH
PASSAGE
TANK ROOM
LABORATORY Nº 2
PASSAGE TO YARD
W.C.
LAV.
CLOAK ROOM
PORCH
PASSAGE
CARE TAKER'S ROOM
PANTRY
BED ROOM
LABORATORY Nº 3
LARDER
STORE
SCULLERY
KITCHEN
l l k m j j j j j
0 5 10 20 30 40 50 Feet

GROUND PLAN.

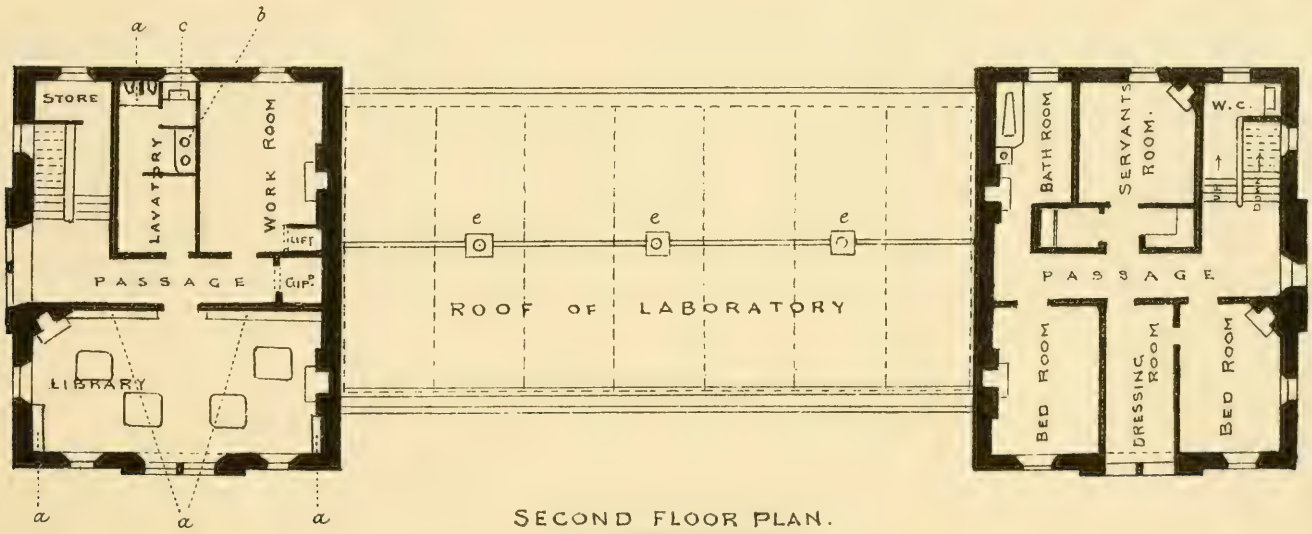


FIRST FLOOR PLAN.



PLAN OF CELLARS AND FOUNDATIONS

0 5 10 20 30 40 50 FEET



SECOND FLOOR PLAN.

MARINE BIOLOGICAL LABORATORY.

Received

Accession No. 946.

Given by Mr. C

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Journal of the Marine Biological Association.

LIST
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1888 Latter, O. H., *Keble College, Oxford* ..... *ann.*
1885 Lea, A. S., M.A., *Trinity College, Cambridge* ..... *ann.*
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1885 Mocatta, F. H., 9, *Connaught Place, W.*..... *C.*
1886 Mond, Ludwig, 20, *Avenue Road, Regent's Park, N.W.*..... *C.*
1884 Moore, Thomas John, C.M.Z.S.L., Curator Free Public Museum, *Liverpool* .... *ann.*
1884 Morgan, C. Lloyd, *University College, Bristol* ..... *ann.*
1885 Morris, John, 13, *Park Street, Grosvenor Square, W.* ..... *C.*
1885 Morrison, Alfred, 16, *Carlton House Terrace* ..... £52 10*s.*

1884 Newton, Prof. Alfred, M.A., F.R.S., *Magdalene College, Cambridge*..... £20
1884 Noble, John, *Park Place, Henley-on-Thames* ..... *ann.*
1884 Norman, Rev. A. M., *Burnmoor Rectory, Fence Houses*..... *ann.*

1885 Oliver, F. W., *Trinity College, Cambridge* ..... *ann.*
1884 Ommaney, Admiral Sir Erasmus, C.B., F.R.S., *The Towers, Yarmouth, Isle of Wight*..... *ann.*
1884 Ormerod, G. W., M.A., F.G.S., *Woodway, Teignmouth*..... *ann.*

1885 Paget, Sir James, Bart., F.R.S., 1, *Harewood Place, Hanover Square, W.* ..... *C.*
1884 Parker, J. J., 54, *Eaton Terrace, S.W.* ..... *ann.*
1884 Parker, W. Newton, *University College, Cardiff* ..... *ann.*
1884 Parsons, Chas. T., *Norfolk Road, Edgbaston, Birmingham* ... *ann.*
1887 Pechey, Miss Edith, *Cumballa Hill, Bombay* ..... *ann.*
1884 Peck, R. Holman, *Elmfield, Penge Lane, Sydenham*..... *ann.*
1885 Phillips, Chas. D. F., M.D., 10, *Henrietta Street, Cavendish Square, W.* ..... *C.*
1884 Pittock, George M., M.B. Lond., 23, *Cecil Square, Margate*... *ann.*
1885 Pochin, H. D., *Bodnant Hall, Eglwysbach, Denbighshire* ..... *C.*

1884 Pollock, Henry, 18, *Hanover Terrace, Regent's Park, N.W.* .... *ann.*
1884 Potter, Michael C., M.A., *Herbarium, New Museums, Cambridge* .... *ann.*
1884 Powell, Thos. Harcourt, *Drinkstone Park, Woolpit, Bury St. Edmunds* .... *C.*
1886 Power, D'Arcy, M.A., F.R.C.S., 26, *Bloomsbury Square, W.C.* *ann.*
1886 Power, Henry, F.R.C.S., 37A, *Great Cumberland Place, W.*... *ann.*
1888 Prance, C. R., M.D., 18, *Princess Square, Plymouth* .... *ann.*
1885 Pritchard, Urban, 3, *George Street, Hanover Square, W.* .... *ann.*
1884 Pye-Smith, P. H., M.D., 54, *Harley Street, W.* .... *C.*

1884 Radford, Daniel, *Mount Tavy, Tavistock* .... *ann.*
1884 Rae, John, LL.D., F.R.S., 4, *Addison Gardens, Kensington, W.* .... *ann.*
1884 Ralli, Mrs. Stephen, *Cleveland House, Clapham Park* £30
1885 Ransom, W. B., *Trinity College, Cambridge* .... *C.*
1887 Riley, W., *Newcastle House, Bridgend, Glamorganshire* .... *ann.*
1884 Rowe, J. Brooking, F.S.A., F.L.S., *Lockyer Street, Plymouth*... *ann.*
1885 Roy, Professor Chas. S., *Trinity College, Cambridge* .... *ann.*
1885 Ruscoe, John, *Albion Works, Henry Street, Hyde, near Manchester* .... *ann.*

1885 Saunders, Rev. J. C., M.A., *Downing College, Cambridge* ... *ann.*
1884 Schäfer, Prof. E. A., F.R.S., *University College, Gower Street, W.C.* .... *ann.*
1888 Scharff, Robert T., M.D., *Science and Art Museum, Dublin*... *ann.*
1884 Sclater, P. Lutley, F.R.S., 3, *Hanover Square, W.* .... *ann.*
1884 Sclater, W. Lutley, 44, *Elveston Place, London, S.W.* .... *ann.*
1885 Scott, D. H., *The Laurels, Bickley, Kent* .... *C.*
1884 Sedgwick, A., M.A., F.R.S., *Trinity College, Cambridge* .... *C.*
1888 Serpell, E. W., 19, *Hill Park Crescent, Plymouth* £50
1885 Sheldon, Miss Lilian, *Newnham College, Cambridge* .... *ann.*
1884 Shipley, Arthur E., *Christ's College, Cambridge* .... *ann.*
1886 Shore, T. W., M.D., *St. Bartholomew's Hospital* .... *ann.*
1884 Sladen, W. Percy, Sec. Linn. Soc., *Orsett House, Ewell, Surrey* .... *ann.*
1884 Smith, Robert Mackay, *Edinburgh* .... *C.*
1884 Sowerby, William, *Royal Botanical Society, Regent's Park, N.W.* .... *ann.*
1884 Spencer, J., 82, *London Street, Greenwich, S.E.* .... *ann.*
1884 Spring-Rice, S. E., 113*a*, *Queen's Gate, W.* .... *C.*
1884 Stalbridge, The Rt. Hon. Lord, 12, *Upper Brook Street, W.*... *ann.*
1884 Staples, Alderman, 87, *Avenue Road, Regent's Park, N.W.* ... *ann.*
1884 Stewart, Prof. Chas., F.L.S., *Royal College of Surgeons* .... *ann.*
1884 Strawbridge, George N., 11, *Blandford Square, N.W.* .... *ann.*

1884 Sutherland, The Rt. Hon. the Duke of, K.G., *Stafford House, St. James', S.W.* ..... *C.*
1888 Swayne, W. Paul, M.R.C.S., *The Crescent, Plymouth* ..... *ann.*

1884 Thompson, Prof. D'Arcy W., *Dundee* ..... *ann.*
1884 Thornycroft, John I., *Eyot Villa, Chiswick Mall* ..... *ann.*
1885 Tylor, E. B., D.C.L., F.R.S., *Museum House, Oxford* ..... *ann.*

1884 Upcher, Henry R., *Sherringham, Cromer* ..... *ann.*

1885 Vaizey, J. Reynolds, *Peterhouse, Cambridge* ..... *ann.*
1884 Vines, Professor Sydney H., M.A., D.Sc., F.R.S., *Botanical Gardens, Oxford* ..... *ann.*

1884 Walker, Alfred O., *Lead Works, Chester* ..... *ann.*
1884 Walker, Rev. F. A., D.D., *Dun Mallard, Cricklewood* ..... *ann.*
1884 Walker, P. F., 36, *Princes Gardens, S.W.* ..... *ann.*
1884 Walsingham, Lord, *Eaton House, Eaton Square, S.W.* £20
1884 Watkins, F. Louis, *Rosemont, Greenhill Road, Hampstead* ... *ann.*
1884 Welch, H. Kemp, 32, *Onslow Gardens* ..... *ann.*
1884 Wilson, Scott B., *Heather Bank, Weybridge Heath* ..... *C.*
1884 Woodall, John W., *St. Nicholas House, Scarborough* ..... *ann.*
1884 Woollcombe, W. G., M.A., F.R.A.S., F.L.S., *Cathedral Close, Exeter* ..... *ann.*
1886 Woollcombe, Surgeon-Major R. W., 14, *Acre Place, Devonport* ..... *ann.*

IV.—Donors, not being Members.

	£	*s.*	*d.*
H.R.H. the Prince of Wales (*Patron*)	25	0	0
The Worshipful Company of Goldsmiths	100	0	0
The Worshipful Company of Skinners	42	0	0
Abercorn, The Duke of, C.B., *Baron's Court, Ireland*	5	0	0
Acland, Sir Henry W. D., K.C.B., F.R.S., *Broad Street, Oxford*	5	0	0
Albright, A. P., *Birmingham*	5	0	0
Ash and Son, C., 9, *Broad Street, Golden Square, W.*	1	1	0
Ball, Prof. R. S., LL.D., F.R.S., *Observatory, Dunsink*	1	1	0
Barrett, G. R., *Portland Square, Plymouth*	1	1	0
Bewes, Rev. Thomas A., *Beaumont, Plymouth*	50	0	0
Blomefield, Leonard, 19, *Belmont, Bath*	5	0	0
Braithwaite, Isaac, 4, *Gloucester Square, W.*	5	5	0
Brooks, H. St. John, M.B., *Dublin*	1	1	0

	£	s.	d.
Burd, J. S., *Mannamead, Plymouth*	2	2	0
Carter, Henry J., *The Cottage, Budleigh, Devon*	5	5	0
Casella, Louis P., F.R.A.S., *The Lawns, Highgate*	1	1	0
Champernowne, A., *Dartington Hall, Totnes*	10	0	0
Clarke, Hyde, 32, *St. George's Square, S.W.*	1	1	0
Darbishire, S. D., 60, *High Street, Oxford*	3	3	0
Devonshire, The Rt. Hon. the Duke of, K.G.	25	0	0
Drysdale, J. J., M.D., 36A, *Rodney Street, Liverpool*	2	2	0
Ducie, The Rt. Hon. the Earl of, 16, *Portman Square, W.*	25	0	0
Farrer, Sir Thos. H., Bart., 27, *Bryanston Square, W.*	10	0	0
Fox, H. B., *Pengenick, Falmouth*	3	3	0
Fry, The Lord Justice	1	0	0
Fung, Yee, 49, *Portland Place, W.*	1	1	0
Gay, F. W., 113, *High Holborn, W.C.*	2	2	0
Goulding, Francis H., *George Street, Plymouth*	1	1	0
Guy, William A., M.B., F.R.S., 12, *Gordon Street*	5	0	0
Harris, A. Saunders, 5, *Gascoigne Place, Plymouth*	3	3	0
Heap, Richard, *Blackmoor, West Derby, Liverpool*	5	0	0
Hingston, C. A., M.D., 2, *Sussex Terrace, Plymouth*	5	0	0
Hodgson, Shadworth H., 45, *Conduit Street, Regent Street, W.*	5	5	0
Hooker, Sir Joseph, K.S.I., C.B., *Royal Gardens, Kew*	10	10	0
Hughes, Professor, *Clare College, Cambridge*	2	2	0
Hull, Edward, LL.D., F.R.S., 14, *Hume Street, Dublin*	3	3	0
Joshua, Samuel, 18, *Westbourne Terrace, Hyde Park, W.*	5	5	0
Lemann, F. C., *Black Friars House, Plymouth*	2	2	0
Lowthian, M. J., *Glenlora, Loch Winnoch, N.B.*	2	2	0
Macmillan & Co., 29 and 30, *Bedford Street, Covent Garden, W.C.*	25	0	0
Marshall, C. F., B.Sc., *Owens College, Manchester*	1	1	0
Matthey, G., 78, *Hatton Garden, E.C.*	5	5	0
Methuen, Rev. Thomas P., *Abbey Lodge, St. Albans*	5	5	0
Miers, Edw. J., *Zoological Department, British Museum, Cromwell Road, S.W.*	2	2	0
Morley, The Rt. Hon. the Earl of, 31, *Prince's Gardens, S.W.*	2	0	0
Neild, Dr., *Sussex Terrace, Plymouth*	1	1	0
Pengelly, Wm , F.R.S., *Torquay*	1	1	0
Ridley, Stuart O., F.L.S., 3, *Christchurch Road, Hampstead, N.W.*	5	5	0
Roberts, Isaac, *Kennessee, Maghull, Liverpool*	6	1	0
Roget, John L., 5, *Randolph Crescent, Maida Hill*	2	2	0
Rosseter, T. B., *Fleur de Lis, Canterbury*	1	1	0
Russell, Lord Arthur, M.P., 2, *Audley Square, W.*	5	0	0
Russell-Rendle, E. M., 11, *Athenæum Place, Plymouth*	1	1	0
Sanders, T. C., 46, *Cleveland Square*	2	0	0

	£	s.	d.
Sanderson, Prof. J. Burdon, F.R.S., *Banbury Road, Oxford* ...	10	10	0
Saunders, Sir Edwin, 13, *Hanover Square, W.*	10	10	0
Shepherds, Mrs. A. B., 17, *Great Cumberland Place, W.*	5	0	0
S. K. I. P., per Arthur W. W. Brown	34	5	0
Square, W. J., F.R.C.S., *Portland Square, Plymouth*	10	0	0
Square, Wm., F.R.C.S., F.R.G.S., *Portland Square, Plymouth*	2	2	0
St. Germans, the Earl of, *Port Eliot, Cornwall*	10	0	0
Teign Naturalists' Field Club, *Teignmouth*	15	15	0
Trist, Major, *Tristford, Harberton, South Devon*	2	2	0
Verney, E. H., Capt. R.N., *Travellers' Club, Pall Mall, S.W.*..	1	1	0

Report of the Council of the Marine Biological Association for the year 1887-88.

PRESENTED AT THE FOURTH ANNUAL GENERAL MEETING OF THE ASSOCIATION, HELD ON JUNE 27TH, 1888, IN THE ROOMS OF THE ROYAL SOCIETY, BURLINGTON HOUSE, LONDON.

I. The Council has met twelve times since the last Annual General Meeting of the Association in June, 1887. The business transacted by the Council has chiefly had reference to the completion of the machinery and fittings of the Plymouth Laboratory. The Council report that the Laboratory is now complete, the apparatus for pumping and circulating sea-water is at work, the tanks are stocked with various fishes and other marine animals and plants, the work-rooms are fitted and actually occupied by naturalists, and a considerable collection of books of reference on marine zoology and botany and on fishery questions is in place in the Library.

On Saturday, June 30th, as already announced to the Members of the Association, the Council will formally open the Laboratory at Plymouth. They have great pleasure in acknowledging the generous assistance afforded to them on this occasion by the Court of the Fishmongers' Company, who not only will be represented at the ceremony by the Prime Warden and other members, but have invited the Members of the Association to a banquet at Plymouth in celebration of the opening of the Laboratory. The interest taken by the Fishmongers' Company in the affairs of the Association has further led them to take a step which will ensure the attendance of nearly all the Members of the Council of the Association at Plymouth on June 30th, and will enable them to examine

the building and appliances which have come into existence through their labours. Through Mr. E. L. Beckwith, the representative of the Company on the Council of the Association, the Members of the Council have been invited to travel to and from Plymouth and to stay there on the occasion of the ceremony of June 30th as the guests of the Fishmongers' Company. The Council desire not only to record their appreciation of the kind consideration shown by this invitation, but to express the belief that the opportunity thus afforded to the Council of inspecting the arrangements of the Laboratory will be of advantage to the Association.

II. On July 26th last Mr. J. T. Cunningham, Fellow of University College, Oxford, was appointed Naturalist to the Association, and at once proceeded to Plymouth, where he has since been steadily occupied in the investigation of the breeding and general natural history of food fishes, especially of the sole, conger, pilchard, and herring. He has furnished the Council with quarterly reports of the work done by him, and will shortly be in a position to publish some results.

III. Mr. W. F. R. Weldon, Fellow of St. John's College, Cambridge, has spent some months at the Laboratory in the study of the development of the common lobster and of the spiny lobster, and in a general study of the Crustacea of the Sound. In this work Mr. Weldon has been assisted, so far as expenditure on boats, fishermen, and material is concerned, by a grant from the Government Grant Fund of the Royal Society, entrusted by the Government Grant Committee to the President of the Association, the Hon. Secretary, Prof. Moseley, and Mr. Adam Sedgwick.

IV. In October Mr. Walter Heape resigned the post of Resident Superintendent, his resignation taking effect in March. The Council determined to appoint, in succession to Mr. Heape, a Director who should be also Secretary of the Association, and attend the meetings of the Council in London. In addition to the salary of £200 a year and a residence, the Council agreed to provide the new Director with funds for the payment of a clerk-assistant. The

terms of the appointment were advertised in the 'Times,' 'Athenæum,' 'Nature,' and in the Plymouth newspapers. There were twelve applications for the post, the list including some of the most distinguished of the younger naturalists of this country as well as foreigners. The choice of the Council fell upon Mr. Gilbert C. Bourne, M.A., Fellow of New College, Oxford, who proceeded to Plymouth in the beginning of June, and has now entire charge of the Laboratory and of the general business and correspondence of the Association.

The Honorary Secretary, Professor Lankester, retains his office, but having during four years personally carried on the correspondence and general management of the affairs of the Association whilst its resources were in course of development and organisation, he has expressed a desire, now that a solid and permanent realisation of the plans of the Association has been secured, to hand over the more laborious portion of the Secretary's duties to a paid official. Accordingly the Council has arranged to provide a salary for a clerk who will assist Mr. Bourne, that gentleman acting as both Resident Director of the Laboratory and Secretary of the Association.

V. Amongst donations to the funds of the Association during the past year the Council has to report £100 from the British Association for the Advancement of Science, £25 from the Goldsmiths' Company, and £25 from Sir Edward Clarke, M.P., the Solicitor-General. The Treasurer's report shows that on completion of the payments for the buildings and fittings and Naturalist's salary, the Association will have about £2000 in hand, apart from investments and annual income, and that it will have disbursed up to the present date about £13,700, of which £12,500 is represented in the actual buildings, fittings, and machinery of the Laboratory. The estimated income of the Association from subscriptions, investments, and subsidies is £900. The Council have determined to expend £440 a year for three years out of the balance of £2000 mentioned above, in the general maintenance of the Laboratory and Staff, so that during these three years they have provided for a budget of £1340. This

expenditure is calculated on an extremely economical scale. The Council feel confident that as the work of the Laboratory progresses and becomes generally known additional funds will be forthcoming for the prosecution of its objects.

At the present moment the most serious deficiency in the equipment of the Laboratory is the want of a small steam vessel which can be used by the Staff of the Laboratory for the purpose of exploring the fishing grounds of the neighbourhood of Plymouth. A special appeal for funds for the purchase and maintenance of such a steamer has been drawn up by the Director and authorized by the Council of the Association, and it is hoped that those who visit the Laboratory on the 30th may mark their approval of the arrangements there made by starting the steamboat fund.

VI. The Council has adopted the following regulations with reference to the admission of naturalists to the use of the Laboratory :

(1) Any Governor or Founder of the Association is entitled to occupy *in propriâ personâ* a table at the Plymouth Laboratory without payment. He shall also have the privilege, upon signifying to the Director his intention to forego permanently the right of personally occupying a table in the Laboratory, of nominating an eligible person to make use of a table for one month in each year free of charge.

(2) The charge for a table shall be £40 a year, £25 for a half year, and £5 for a month, to be paid in advance. No table shall be let for less than a month, and the monthly charge shall be as above for any number of months less than six.

(3) Members of the Association have the first claim to become renters of tables.

(4) Life Members of the Association are entitled to occupy *in propriâ personâ* a table at a reduction of one fourth from the above rates.

(5) The Council of the Association may remit, in whole or in part, the payment of rent for a table in special cases. No charge will be made to a State-recognised authority for the use of a table.

(6) Applications from Members and others desiring to occupy tables must be made to the Director of the Laboratory of the Marine Biological Association, Plymouth.

(7) The Association undertakes, so far as possible, to supply the material required for any investigation, and such facilities for obtaining it as may be at the command of the Association.

(8) The Association supplies to the occupant of each table ordinary glass jars, dissecting dishes, bottles, pans, &c., not to be

removed from the Laboratory; also ordinary chemical reagents, and a limited amount of ordinary methylated alcohol. The Association does not supply absolute alcohol, nor does it provide microscopes or other instruments. The more expensive reagents, as well as glass slips and covers, and other portable apparatus, may be purchased of the attendant.

(9) For the purpose of enabling the Director to draw up the half-yearly statement of the work of the Laboratory required by H.M. Government, and for the information of the Association, all naturalists working in the Laboratory at the completion of their work, or if not completed after three months then at intervals of three months, are expected to furnish the Director with a summary statement of the investigations carried on by them in a form suitable for publication in the Journal of the Association.

(10) Any Member of the Association is at liberty to view the Laboratory and tanks between the hours of 10 a.m. and 6 p.m. on presenting his card to the Director.

VII. A committee of the Council, consisting of Dr. Günther, Mr. Sedgwick, and Prof. Bell, has undertaken during the past year the formation of the nucleus of a Library. They have been authorized to expend £188 on the purchase of books, and have also made applications for gifts of books to various sources. A valuable collection of works has thus been brought together, and in future it will be the business of the Director to make purchases for the Library and to apply for gifts of books. A sum of £100 a year has been assigned by the Council for the maintenance of the Library and purchase of books.

A catalogue of the Library will be printed in the next number of the Journal of the Association (No. 2), and it is hoped that Members and friends of the Association will assist in making the Library as complete as possible by presenting their own publications or other works which they can spare.

VIII. The Council has to record the death during the past year of one of its most energetic supporters and a Vice-President of the Association, the Earl of Dalhousie. The late Earl, as Chairman of the Royal Commission on Trawling, took a deep interest in the study of fishery problems, and made himself practically acquainted with sea fisheries by accompanying the fishermen in their cruises. It is largely due to the advocacy of the late Earl of Dalhousie and the

report of the Commission over which he presided, that the Association owes the support which it has received from public funds.

IX. The Council desire to record the indebtedness of the Association to the Councils of both the Linnean Society and the Royal Society for kindly permitting the Association to make use of rooms belonging to those societies for the purpose of the periodic meetings of the Council and Association.

X. The following is the list of officers, Vice-Presidents, and Council proposed by the Council for the year 1888–89. The President of the Association, Professor Huxley, has consented to remain in office for the present, although he has expressed a wish to retire on account of his health not permitting him to give so much attention as heretofore to the business of the Association. Owing to illness, Professor Moseley is also unable to act any longer as Chairman of the Council. It is with the deepest regret that the Council record the retirement of Professor Moseley, whose work in connection with the plans for the Laboratory and its fittings was of the greatest value, whilst in all matters and at all times he has been the most earnest and generous supporter of the enterprise taken in hand by the Association.

President.—Professor Huxley, F.R.S.

Vice-Presidents.—The Duke of Argyll, K.G., F.R.S.; The Duke of Sutherland, K.G.; The Duke of Abercorn, C.B.; The Earl of St. Germans; Lord Walsingham, F.R.S.; The Right Hon. A. J. Balfour, M.P.; The Right Hon. Joseph Chamberlain, M.P.; Prof. G. J. Allman, F.R.S.; Sir Edward Birkbeck, M.P.; Prof. Flower, C.B., F.R.S.; Sir John Lubbock, Bart., M.P., F.R.S.; Prof. Alfred Newton, F.R.S.; Captain Wharton, R.N., F.R.S.

Hon. Treasurer.—Mr. Frank Crisp, V.P.L.S.

Hon. Secretary.—Professor Ray Lankester, F.R.S.

Council.—Mr. C. Spence Bate, F.R.S.; Prof. Jeffrey Bell; Mr. W. S. Caine, M.P.; Mr. W. H. Caldwell, M.A.; Mr. Thiselton Dyer, C.M.G., F.R.S.; Dr. John Evans, Treas. R.S.; Prof. Ewart, M.D.; Dr. A. C. L. G. Günther, F.R.S.; Mr. E. W. H. Holdsworth, F.L.S., F.Z.S.; Mr. E. B. Poulton, M.A.;

Dr. G. J. Romanes, F.R.S.; Dr. P. L. Sclater, F.R.S.; Mr. Adam Sedgwick, F.R.S.; Prof. Charles Stewart; Mr. W. F. R. Weldon, M.A.

In addition to the above the following gentlemen, as Governors of the Association, are *ex officio* members of the Council :—Mr. Robert Bayly; Mr. John Bayly; The Prime Warden of the Fishmongers' Company; Mr. E. L. Beckwith; Mr. Bazley White; Prof. Burdon Sanderson, M.D.; Prof. Michael Foster, F.R.S.

Mr. E. L. Beckwith to be Chairman of the Council.

The Fourth Annual General Meeting of the Association was held in the Royal Society's rooms on Wednesday, June 27th, at 5 p.m. In the absence of the President, Prof. Flower, one of the Vice-Presidents of the Association, took the chair.

The Hon. Secretary (Prof. Ray Lankester) read the Report of Council (printed above), which was adopted unanimously.

The Hon. Treasurer (Mr. F. Crisp) read the statement of accounts for the past year, and his report was agreed to unanimously.

On the motion of Prof. Jeffrey Bell a vote of thanks was passed to the Treasurer for his services.

Dr. Evans moved a vote of thanks to the Hon. Secretary (Prof. E. Ray Lankester) for his services to the Association. He said that before separating the meeting would be glad to offer a hearty vote of thanks to Prof. Lankester for all the services that he had rendered to the Association. It was true, and it was gratifying that it was true, that he was not retiring from the post of Honorary Secretary, but he would now be relieved, at all events to some extent, from that part of the labours of the office that could be performed by others. Dr. Evans had been a member of the Council ever since the day when the Association was first started, and had thus had some opportunity of forming an idea of the enormous amount of thought, time, and labour that Prof.

Lankester had bestowed in promoting the welfare of the Association. Not only had he brought his great scientific knowledge and experience to bear in every department of the work, but the amount of actual drudgery that he had gone through was almost incredible,—in raising funds, in negotiating with public bodies, in carrying on correspondence, in drawing reports, in examining plans, and in all the varied details of the great undertaking of erecting and starting this Laboratory, it was always Prof. Lankester who took the labouring oar. He was happy to think that his invaluable services would still be freely rendered to the Association, while some of the more irksome routine work would be performed by others, and he was sure that the meeting would be unanimous in offering to Prof. Lankester their warmest and most cordial thanks for all the work he had so successfully carried out, the results of which would shortly be more apparent when the Laboratory was formally opened to the public and became available for occupation by naturalists.

The Hon. Treasurer (Mr. F. Crisp) in seconding the motion said that he had, by reason of his office, a better opportunity of knowing the work done for the Association by Prof. Lankester than any other person. It surprised him that amongst his many and various engagements Prof. Lankester should have been able to find the time and give the thought that he had given to the affairs of the Association. The work to be done must have often been distasteful to a man of his attainments, and most of it was sheer drudgery, yet Prof. Lankester had applied himself to it in a most cheerful and determined spirit, and had carried it through in spite of great difficulties. To him belonged the credit of starting the Marine Biological Association, and to his ability and perseverance the realisation of the objects of the Association was due. The time had come when he, having organised the work of the Association and seen the completion of the Laboratory, was about to hand over his duties to others, and it was only fitting that he should receive a due acknowledgment of his great services, and he (Mr. Crisp) had great pleasure in seconding the motion.

Prof. Flower in putting the motion said that he did so with the greatest pleasure. The Association owed its very existence to the ability and energy of Prof. Lankester, and it was entirely through his self-sacrifice and spirit that they found themselves in the position they now were. Prof. Lankester having borne the work of starting the Association on its career would now leave details and routine work to other hands, but he was glad to see that he would retain office as Hon. Secretary, and hoped that he would long be able to assist the Association with his experience. The motion was carried enthusiastically.

Prof. Ray Lankester in returning thanks referred to the assistance that he had received from scientific men, and from various societies and corporations, particularly from the Royal and Linnean Societies, who had placed their rooms at the disposal of the Association. He had in addition received cordial assistance from private individuals and from the great City companies, among whom the Fishmongers' Company were conspicuous for their liberal and enlightened patronage of the Association. In the heavy work of arranging the details of the building of the Laboratory he had had the warmest assistance from his scientific friends, and especially from Mr. Thiselton Dyer, Prof. Moseley, and Mr. Adam Sedgwick, nor must he omit to mention the services of Mr. Frank Crisp, the Hon. Treasurer of the Association.

A vote of thanks to Prof. Flower for his services in the chair was moved and carried, and the proceedings then terminated.

The Treasurer's report shows that during the year there was received from Donations and Subscriptions £848 13*s.*, with £2500 from H.M. Treasury and from Interest on Investments £159 2s. 10*d.*, whilst there was paid to the contractors £5043 7*s.* 6*d.*, for salaries £849 0*s.* 3*d.*, for books £177 19*s.* 3*d.*, for apparatus and chemicals £223 7*s.* 9*d.*, for printing, stationery, and advertising £96 5*s.* 3*d.*, and for sundries £31 7*s.* 4*d.* The Donations assured but not yet received from all sources (exclusive of the annual grant of £500 a year for five years to be paid by Her Majesty's Government during the years 1888–92), amount to £700, leaving a total estimated balance at date of nearly **£6000**. A considerable portion of this balance is, however, due to the contractors for building the Laboratory and fitting the tank-room.

Opening of the Marine Biological Laboratory.

The ceremony of opening the Laboratory at Plymouth on Saturday, June 30th, was favoured by magnificent weather, and those who travelled down to Plymouth on that occasion, and saw for the first time the building which has been erected on the Citadel Hill, had ample cause to be satisfied with the Laboratory itself and the situation in which it is placed.

The success of the ceremony was assured when the Fishmongers' Company undertook to add to their already munificent patronage of the Association by providing a *déjeûner* for the entertainment of the visitors after the opening of the Laboratory. To their hospitality and kindness much of the success that attended the gathering is due.

It was unfortunate that from ill-health, pressure of Parliamentary work, absence from England, and other causes, many distinguished members of the Association were unavoidably absent from so interesting a gathering. Above all, the absence of Prof. Huxley, the President of the Association, was regretted; ill-health prevented him from undertaking the fatigue of the long journey, and for the same reason Prof. Moseley, who has taken so active a share in the formation of the Association, and has had a large share in the arrangement and fitting of the Laboratory, was unfortunately unable to be present. Prof. Allman, to his own and his friends' great regret, was unable to undertake the journey, and various causes prevented the Duke of Argyll, the Duke of Abercorn, the Earl of Derby, Lord Walsingham, Sir Edward Birkbeck, the Right Hon. Joseph Chamberlain, the Right Hon. A. J. Balfour, Sir John Lubbock, Mr. W. S. Caine, and several others, from attending the ceremony. These noblemen and gentlemen have been among the most

active and generous supporters of the Association, and wrote to express their extreme regret that they were unable to be present.

The proceedings commenced at 10 a.m., and in a short time the laboratories and tank room, which had been decorated for the occasion, were filled with visitors. Amongst those present were: the Prime Warden of the Fishmongers' Company, Sir James Clarke Lawrence, accompanied by Messrs. George Weston, W. C. Venning, J. S. Lister, J. Travers Smith, R. B. Martin, and E. L. Beckwith, Members of the Court of the Company; the Earl of Morley, Sir Edward Watkin, Sir George Paget, the Mayors of Plymouth and Devonport, Sir Edwin Saunders, Prof. E. Ray Lankester, Prof. Michael Foster, Prof. Flower, Mr. Thiselton Dyer, Prof. Milnes Marshall, Captain Wharton, Mr. John Evans, Dr. A. Günther, Mr. Adam Sedgwick, Major-General Lyons, Vice-Admiral Grant, Prof. Charles Stewart, Messrs. E. W. Holdsworth, W. Pengelly, Frank Crisp, Spence Bate, H. Trueman Wood, Prof. D'Arcy Thompson, Mr. Robert Bayly, Archdeacon Wilkinson, Prof. Jeffrey Bell, Prof. J. W. Groves, Dr. Sydney Hickson, Mr. A. D. Berrington, Mr. H. D. Pochin, Mr. J. W. Woodhall, Prof. G. B. Howes, Mr. Allen Harker, Mr. J. Wrench Towse, Mr. T. Bulteel, and many others.

The building has been fully described in the first number of the Journal. Although it was practically complete, time had not allowed the full equipment of the Laboratory to be carried out, and the shelves of the library bore witness to the necessities of the Association in the matter of zoological and botanical literature. Circulation had been established in the tanks for some time previous, and the tanks themselves contained a few marine forms collected by the dredge and trawl during the preceding week. The short time at the disposal of the staff, and the numerous interruptions and delays accompanying the completion of the building, had not allowed them to exhibit more than the most meagre presentment of the rich and varied Fauna and Flora that is to be found in Plymouth Sound and the neighbourhood. All that could be done was to show the capacity of the Association

for carrying on marine investigations in the future, and all those who had the opportunity of inspecting the arrangements were able to express their complete satisfaction with the manner in which its funds had been expended.

Shortly after eleven o'clock Prof. FLOWER, taking the Chair in the absence of Prof. Huxley, delivered the following address :

Before entering upon the actual business of the day, I must express my deep regret, which I am sure is shared by everyone here, that the inauguration of this important undertaking is not to be performed by one who in every way would be best qualified for such an office. Our President is not only the foremost biologist of the day, but one whose great reputation as an original observer was first established by that remarkable series of researches into the structure of oceanic organisms conducted while serving as a medical officer on board one of Her Majesty's ships, who has since, amid all his varied avocations, been continually associated, both officially and as a scientific investigator, with problems concerning the life-history of marine animals, who has been intimately connected with the working of this Association since the day he presided over the meeting held at Burlington House in 1884, at which it was first launched into the world, and whose eloquent words would certainly have added interest, pleasure, and instruction to such an occasion as this. Nothing but the severe indisposition from which he is now unhappily suffering would have prevented his being here, as this Association is one in the success of which he feels the deepest interest. Next to our President, we also lament the absence from a similar cause of one who, as Chairman of the Council, has worked hard to bring the Association into its present successful condition, and who, from his great experience of the conditions of animal and plant life in the ocean, gained during the memorable voyage of the "Challenger," and his profound acquaintance with the scientific aspects of all those questions the solution of which we propose to ourselves, would have been eminently fitted to perform the functions which I have been asked now to undertake.

The objects of this Association are familiar to everyone here. As originally and briefly defined, they are "to promote accurate researches leading to the improvement of Zoological and Botanical science, and to an increase of our knowledge as regards the food, life-conditions, and habits of British food-fishes and molluscs." In the present day there can be little necessity for endeavouring to impress upon an assembly of educated persons that any institution which has for its object the increase of our knowledge of natural phenomena must be a good one. Though I am far from believing that such knowledge can prove by itself a panacea for all human ills, the desire to obtain it is, without doubt, a necessary accompaniment of the high civilisation of our age. The knowledge of nature is valued by many for its own sake. It is valued by many more for the practical advantages to the material welfare of mankind that are certain to flow from it sooner or later. It is scarcely possible to name one of the marvellous improvements which have taken place in late years, that have added so much to the convenience, the comfort, the capabilities of human life, that has not been, when traced back to its source, the outcome of scientific search undertaken originally for its own sake. The means by which such knowledge can be obtained are manifold, and a people who wish to occupy a foremost place in the ranks of civilisation and culture cannot afford to neglect any of them. The special one for the inauguration of which we are assembled to-day is characteristic of the modern development of biological science. The necessity for such institutions as this has been felt almost simultaneously throughout the cultivated nations of the world. The British Isles, with their extensive and varied seaboard, offering marvellous facilities for the investigation of marine life, and with their vast economical interests in the denizens of the waters that bathe their shores, have been rather behind some other countries in adopting this line of research. Let us hope, however, that being so, we may profit by the example and experience of others, and ultimately, as in so many other similar cases, may outrun our neighbours in a department of work for

which our maritime and insular position seems so specially to fit us. That our country should be alone in neglecting this branch of scientific inquiry was impossible. Stations for the investigation of the phenomena of marine life have been founded at several places on the northern coasts of our island, but all on a very limited scale. An institution commensurate with the importance of the subject and of the nation had to be established sooner or later. The only questions to be solved were, *when* it was to be founded and *where* it was to be placed. Much of the success of an enterprise must depend upon the particular time selected for embarking upon it. If delayed too long, the world is a loser by the non-existence of the knowledge that is to be gained from it. On the other hand, premature attempts, before sufficient interest in the subject is awakened, and before sufficient information as to the best means of carrying it out has been gained, often end in failure. I think that in this respect we have taken the right medium. The Fisheries Exhibition at South Kensington in 1883 brought the importance of the enormous food-supply that the sea yields, and the necessity of obtaining more knowledge of how it might best be cultivated and harvested, prominently before the public, and although the profits of the Exhibition were of no direct benefit to our institution, it was doubtless a means of exciting attention to our work. The interest which H.R.H. the Prince of Wales took in that Exhibition was extended to this Association when he became its patron and a liberal contributor to its funds. I think that I may say the same of the Worshipful Company of Fishmongers of the City of London, without whose enlightened and munificent support we should certainly not be in the position we occupy at present. We were also fortunate at the time of our foundation in having a Government in office which recognised the practical importance of our work, as calculated to benefit not only the interests of the fishing industry, but those of the community at large, and liberally responded to our appeal for assistance in this national undertaking, both in providing funds and a site for a building.

Next, as to the place at which our headquarters were to be established. That was at first a matter of considerable difficulty. Many were the rival claimants, but Plymouth was finally chosen, as best affording the requisite physical and geographical surroundings for such an institution, and the liberality with which the Association was welcomed by its leading citizens was in itself a ground of justification for the choice. Though a portion of the old military defences of the town have been given up to our peaceful enterprise, we trust the safety of the inhabitants will not suffer. The Laboratory now stands between the citadel of Plymouth and the sea, and an enemy entering the town by the most direct way would have to march over the ruins of this building. That consideration alone should be enough to secure your safety in a war with any of the enlightened, science-loving nations of Europe, should such an event ever unhappily arise.

As to the institution itself, few words are needed to describe how excellent is its adaptation to the purpose for which it is founded. Although still not in all respects in full working order, we have all been enabled to see to-day how carefully it has been planned, and how well the design has been carried out. We have secured a capable and energetic working staff; students are already taking their places at our Laboratory tables, and already a commencement has been made in their original investigations and contributions to knowledge, which we hope will be of such a character and of such abundance as to give this Laboratory a high place among the scientific institutions of the world. Our present financial position and future needs are fully set forth in the Report of the Council just issued. This shows that of our capital already subscribed the greater part has been expended upon the building and necessary apparatus for its equipment. We still want a small steam vessel for the use of the staff in exploring the fishing grounds of the neighbourhood and for collecting materials to stock our tanks. For the means of providing this, and for the annual maintenance of our establishment in a state of efficiency, we shall require further pecuniary assistance. But as the

Report is or will shortly be in your hands, I need not detain you longer by enlarging upon its contents, which part of the ceremony is still to come elsewhere. I will therefore now, in the name of the President and Council of the Marine Biological Association of the United Kingdom, thank all those who have by their generous contributions of money, or by expenditure of their time, labour, and thought, brought us so far on our way, and *declare the Laboratory of the Association open for work*. May we all join in the earnest hope that the expectations which have been raised of its future usefulness may never be disappointed!

After Prof. Flower's address the company adjourned to the *déjeûner* at the Grand Hotel. The Prime Warden of the Fishmongers' Company presided, and at the conclusion of the meal the following speeches were made:

The Prime Warden proposed "The Queen." Referring to the fifty years of the Queen's reign, he asked them to consider how great had been the progress in art, in science, and in commerce during that period. But greater than all, greater than the progress in art or in science, had been the progress in the material welfare of the masses of the people. He believed that no sovereign who had ever reigned had had her name mentioned in the same genuine terms of sincere admiration as that of Queen Victoria was received in all parts of the kingdom. Long might the Queen reign over a loyal and a prosperous people, and might she long continue the Queen of the United Kingdom of Great Britain and Ireland!

The Earl of Morley gave "The Marine Biological Association of the United Kingdom." He said that he felt very grateful for the compliment paid him in associating his name with the toast as its proposer, but he feared that the qualifications he had for performing that duty were very meagre indeed. This came home to him especially when he saw around him so distinguished a company, among which were many of the greatest and best known scientific men in England. But he presumed that the reason this important toast had been entrusted to him was that he was connected with the neighbourhood in which they had

selected the site for their first Laboratory, and as such he gratefully accepted the duty, and would do the best he could to do justice to it. Before making any remarks as to the work which was to be performed in that Laboratory, he might perhaps be allowed—and he was sure that the Mayors of Plymouth and Devonport would join with him—to wish a hearty welcome to the distinguished company present to the West of England, and to express the hope that the Laboratory which Professor Flower had opened with such an admirable and instructive address that morning would attract scientific men like themselves to pay constant visits to the town and neighbourhood. It was not necessary for him to explain the importance and interest of the present occasion. If he wished to call witnesses he should merely ask them to look at the company assembled around the hospitable board of the Worshipful Company of Fishmongers. And if they had any doubts as to the practical value of the work, any such doubts would be dissipated by the simple fact that they found the Prime Warden and his colleagues coming from the atmosphere of actual work on the banks of the Thames to found this interesting Laboratory. If, on the other hand, he wished to call witnesses as to the probable scientific value of the work, he should merely have to appeal to the revered and well-known names of many gentlemen around him, and among them the directors of the great national institutions at South Kensington and Kew, and to show what they at any rate anticipated would be the results of the investigations which would be conducted under the care of the able superintendent and his assistants. There was, in fact, such a consensus of opinion, both from a practical and scientific point of view, of the value of the work that would be done there, that the thing which surprised him was why it had not been done before. How was it that we, who more than any other nation in the globe reaped the richest harvest from the sea, had never yet endeavoured scientifically to inquire into the sources of this great industry and article of food? How was it that we had lagged behind other nations, some of whom might be almost regarded as inland countries? France, he believed, had

already not less than four institutions of a similar kind, namely, at Roscoff, Concarneau, Villefranche, and one in the Mediterranean at Cette. Austria, with only a small sea coast, had one at Trieste; and, more important than all, at Naples the German Government were annually giving £1500 a year to a laboratory of the same kind, and he believed that he was right in saying that it was the most complete in existence. If we went to the other side of the Atlantic we found that Professor Agassiz had instituted at Newport a most admirable institution, the work of which had already been rewarded with marked practical success. He desired to say a few words as to the importance of British fisheries. Certain statistics were lately given to Parliament by the Board of Trade which he might summarise very shortly. The production of fish in the United Kingdom of Great Britain and Ireland amounted to no less than 598,000 tons last year, and the value of this fish at the port of landing was £6,390,000. The whole industry was not, however, represented by that sum, for he believed that the retail value of the fish would amount to at least £13,000,000 a year. The East coast was, of course, by far the most fruitful of all our coasts for fishing. Grimsby, Hull, Lowestoft, and Yarmouth between them produced no less than £2,846,000 worth of fish during the year. Though Plymouth followed at a long interval, yet at this port they had no less than £96,000 worth of fish during the year. That amount was for Plymouth only, but there were also various fishing ports in the district, such as Brixham, with £56,000, and Penzance, £41,000, which gave a very good idea of what a vast harvest there was to be reaped from the sea, a harvest by the way which we had never sown. He would compare those results with other countries which had already done something for the scientific investigation of fisheries. Canada did not produce in 1886 more than £3,892,000 worth of fish, and France even less, namely, £3,709,000 worth. Another aspect of the trade was the amount of traffic it gave to the railways, on which he might appeal to his friend Sir Edward Watkin for confirmation; even from Plymouth no less than 5000 tons were conveyed annually. He would

not go further into statistics, but he thought it desirable to give them an idea of the great industry they were seeking to promote. Every other branch of industry had invoked the aid of science, and not invoked it in vain. Our fisheries, from the nature of the case, and from the condition in which the animals we were anxious to catch lived, were extraordinarily difficult for observation and experiment, which could only be conducted at a cost which was not within the means of private individuals. It seemed extraordinary, however, that so many years should elapse without scientific efforts being made ; for we must recognise more and more that the wealth of nations and individuals depended on the economical and ample use of the powers of nature. The use of those powers depended on our knowledge of them, and that knowledge could only be obtained by observation and experiment ; not conducted haphazard, but by scientific men and in a methodical way. From day to day, as science broadened down and increased its area, and its great generalisations became applied in all directions, we became more and more impressed with the fact that man is the minister and interpreter of nature, and, in the words of the great father of inductive science, in both of these science must and can only depend on accurate experiment and observation. If they read some of the interesting reports of the Trawling and Fishing Commissions that had appeared lately they could not fail to be struck with the utter ignorance as to the habits of fish, as to their modes of existence, their food, the manner and the places in which they multiplied their species, the climatic and other effects which influenced them in their migrations, and in all their modes of life, shown by the fishermen. But he was afraid that that ignorance was not confined to the fishermen. The great authorities that he saw around him—and there were none greater in England, or perhaps in Europe—would, he believed, confirm his remarks that we knew very little indeed of the migrations of fish. That great want was, he now hoped, about to be supplied. They had seen the Laboratory, and though he did not for a moment express an opinion on it himself, yet he gathered

from his friends around him that it was admirably equipped and supplied with all the apparatus required for these investigations. For this result they were indebted to the Prime Warden and his colleagues, and also to another distinguished Company in the City, and further, to the munificent donation of a gentleman of this locality, whom he was proud to see among them that day. If funds were wanting to carry on a work that had been inaugurated under such favorable auspices, he sincerely hoped that they would be found, and that Mr. Bourne, the able curator of the institution—would have a successful career before him, both from a scientific and practical point of view. Perhaps practical results might not be expected, but he would recall the interesting remarks made by Sir Lyon Playfair—who he regretted was not present—of how the American laboratories succeeded in artificially producing immense numbers of cod (which sometimes left the shores of the New England coast for the colder shores of Newfoundland), to the great benefit of the consumer. Again, a certain fish much esteemed on those coasts, the American shad, required for the fertilization of its eggs a certain condition of temperature, and the Commission was able to hatch them when under certain conditions of climate they would not have been hatched naturally. These were striking instances of what science was able to do, and he felt certain that from that Laboratory numberless suggestions would emanate as the habits of various fish became thoroughly known and investigated. They would ascertain what grounds the fishes liked, what foods they liked, what were the causes of their migration; very likely would improve the fisheries themselves; but, still more, might make regulations to prevent the fish being unduly disturbed or destroyed at wrong seasons. These were all things which would develop themselves in future; but before concluding he should like to say one word more on the purely scientific aspect of the Laboratory, though, perhaps, he was a little over-bold in alluding to it. Biological research is the highest though most complicated of any branch of science, and when they considered the large amount of organic life in the sea—forms leading up from the lowest and

least specialised to the greatest fish—what a field there was for research and for tracing out evidences of that wonderful revelation of continuous development from the lower to higher forms—a revelation which we owed mainly to the indefatigable observation and marvellous structural genius of that great man whose biography was now interesting us! Who could tell what results would follow from scientific observations on the practice of the industry they were met to promote? He would conclude by heartily wishing, as he was sure that all present did, "Success to the Laboratory," and he had great pleasure in coupling with the toast the name of one to whom the Laboratory and the Association owed so deep a debt of gratitude—Professor Ray Lankester.

Prof. Ray Lankester said it was with feelings of pride that he rose to return thanks. He felt in the happy position of one who had seen a dream realised. The Laboratory which had been that day opened was due entirely to the associated work of a number of individuals, and, in fact, he thought that the Marine Biological Association must be regarded as a remarkable example of the combination of individuals for a common purpose. The Association was started in the first instance by a few scientific men, who gradually obtained the co-operation of practical and wealthy men and of great Corporations, until they were at last able to bring into existence the institution they had seen that day. Perhaps he might be allowed on that occasion to give a brief history of the steps which the Association had gone through in the gradual evolution of that building, but before doing so he wished to say just a word as to the general purposes of the Laboratory and the work of the Association. It had been stated elsewhere—though he thought no one present was likely to make the mistake—that the Association was not intended for purely scientific research but for inquiries with a practical end in view. He thought he might be allowed to say that such a distinction could not be drawn. All purely scientific research had a practical end. They might not be able to tell what the practical end might be; but they pursued scientific research with the conviction that the progress of knowledge must lead to practical

benefits. On the other hand, they also knew that any attempt to make inquiry with a practical end in view which should ignore scientific methods and aim too directly at the practical end was fraught with danger and almost certain failure. The only way to attain success was to cultivate the tree of science first, and then gather the fruit; they could not grow the fruit without attending to the tree. It was in that spirit that a large number of the friends of science, not only scientific men, but friends of science throughout the country, and civic Corporations—for in addition to the important and valued aid of the Fishmongers' Company they had had the help of the Corporation of London and other bodies—had come forward to contribute to the funds of the Association. He should say that the notion of forming the Association originated with that most important and admirable exhibition, the great Fisheries Exhibition, which they owed to the initiative of Sir Edward Birkbeck, whom he had hoped to have seen with them that day. That was what suggested to him the movement for the formation of a laboratory where fishery studies could be carried on. The idea he had in view at that time, or rather the institution existing elsewhere which he wished to copy, was that established by Dr. Dohrn at Naples, with which they were all familiar. The question was, how could such a laboratory be put up on the British Coast? It was to his friend Dr. Günther, of the British Museum, that he owed the suggestion of the formation of an association. It was to the officers of the Royal Society that he owed the opportunity of starting the Association at a meeting called in the rooms of that Society and presided over by the illustrious President of that great scientific institution, which was also the first public body to support the funds of the Association with a large and handsome subscription. The meeting was very largely attended by men of science and gentlemen interested in fisheries. The late Earl of Dalhousie, one of their most ardent supporters, the Duke of Argyll, and other public men took part in it. The newspaper Press had all along helped them in a most admirable and cheering manner. The 'Times' had been their warmest friend, and he hoped

it would continue to be so for years to come. No sooner had the first start been made at the meeting in the rooms of the Royal Society and the subscription list put forward, than many other big societies came in and individuals throughout the country put down their money. Including the Universities of Oxford and Cambridge, subscriptions had been received from purely scientific bodies and individuals to the amount of £3000, and from various sources a total sum of £16,000 to £17,000 had been obtained. The most important item of support given to the Association was the grant from Her Majesty's Government of £5000 and £500 a year. The remaining £10,000 they owed to the great civic companies and to munificent individuals, among whom he must not omit to mention with hearty gratitude their friends Mr. John Bayly and Mr. Robert Bayly, of Plymouth. No sooner had the enterprise been put on foot than H.R.H. the Prince of Wales expressed his willingness to become a patron of the institution, and support came in on every side. The Inspector-General of Fortifications (Sir Andrew Clarke) and the Earl of Morley were instrumental—were, in fact, the actual causes of their receiving the grant of the splendid site on which the building had been erected, and the co-operation and consent of the Town Council of Plymouth, who had certain rights over the area, were cheerfully given. They had now arrived at a definite stage in their work. The building was completed, the laboratory was equipped, the naturalists were on the spot, and they had thus, as he had said, accomplished what he considered to be the first step in the work of the Association. But it was only the first step. Beyond the mere existence of the Laboratory building, they had still to justify themselves in the eyes of their supporters by the work that was done within it. He thought they might rely upon the staff they had been fortunate enough to obtain. He had the greatest confidence in the work that would be done in the institution, and in the direction which would be given to that work by his friend Mr. Gilbert Bourne, assisted by the experience of his friend Mr. Cunningham, who had come to them fresh from his work in Scotland, and students of all ages and of all groups of marine animals would make

use of the Laboratory now it was once finished. Before concluding what he had to say he should like to express, on behalf of the Association, their great indebtedness to the gentleman who had erected the building and had acted as engineer,—Mr. Inglis. Mr. Inglis had acted throughout with true friendship to the Association, and with the greatest skill and courtesy he had given all possible attention and labour, sparing himself in no way, in order to do the work thoroughly, to obtain the best of everything for the Association, and to carry out the whole scheme in the best manner. He would mention once more a subject which had been already alluded to. They wanted a yacht of their own, not a pleasure yacht, but a steam sea-going vessel which could accompany the trawlers on their expeditions, and which should be a thoroughly seaworthy boat. He hoped that those who were able to place additional funds at their disposal, and who had been pleased and gratified with the way in which they had expended the money already entrusted to them, would not delay to add to the resources of the Association so as to enable them to purchase this steamer.

The Prime Warden then proposed "Prosperity to Plymouth." Not many words were necessary on that subject. Plymouth was no new town. It had a fine history; and if time permitted, one might sketch that time of England's peril when out of that fine harbour went forth that glorious fleet to attack and destroy the Spanish Armada. Near him sat his Worship the Mayor of Plymouth, adorned with the chain which Sir Francis Drake himself wore three hundred years ago. He would not detain them by dwelling on those themes, but he might be permitted to say that it had been a delight to the Biological Association to find itself so well supported by the Corporation of Plymouth, who were doing so much to adorn the immediate neighbourhood of the Laboratory. He had therefore very great pleasure in proposing the toast of "Plymouth," and connecting it with the Mayor who so worthily presided over Plymouth.

The Mayor of Plymouth, in returning thanks, said Plymouth was indebted to the Biological Association for the

very noble building which they had placed within the borough. If they were proud of Plymouth before they should be doubly proud of it now that it had an institution which it had never possessed before. He had visited the Laboratory at Naples, and knew that it was visited by hundreds and thousands of English people. Probably few people were aware of the magnificent view obtainable from the Laboratory. Plymouth people were very proud of their bay; it was not certainly so large as that of Naples, but it was quite as beautiful. It had been called the Bay of Naples in miniature, and he was quite certain that, whatever attractions it had before, the Biological Laboratory would prove an additional one.

Sir GEORGE PAGET proposed "The Health of the Prime Warden," and paid a graceful compliment to his hospitality. Alluding to the practical results arising from science, he pointed out that navigation would be impossible except for the appliances of science. Again, travelling by steam was the practical outcome of scientific discovery, and the same might be said of the telegraph. But whether practical advantages were speedily advanced or not they were casting their bread upon the waters.

The PRIME WARDEN, in response, said it was a great pleasure to him that his other engagements enabled him to revisit Plymouth. He had often visited the town before; but, as he told his friend the Mayor yesterday, he scarcely recognised some portions of it on account of the great improvements which had been made. Reference had been made to the great progress made generally during the last few years. Certainly in this age of progress Plymouth had not been behindhand, and he thought it had at length attained the position of the Metropolis of the West. Long might it hold that position, and long might the Fishmongers' Company feel that in contributing in any way to the benefit of the town of Plymouth and to the advancement of science at the same time, they were in their proper place, doing their proper duty.

In the afternoon those who had not to return to London were able, through the kindness of Lord John Hay, Admiral

of the Port, to take a cruise round Plymouth Sound and up the Hamoaze as far as Saltash Bridge. Lord John Hay courteously placed his fine steam yacht "Vivid" at the disposal of the Association, and hospitably entertained his visitors on board. A smaller party took advantage of the kindness of Mr. G. F. Watson, the owner of the trawler 'Lola," which has several times been requisitioned for the purposes of the Association, and enjoyed a sail round the Breakwater and bays of the Sound.

This account of the opening ceremony cannot be concluded without an acknowledgment of the hospitable welcome given to the Members of the Association by the citizens of Plymouth. The courtesy of the Port Admiral has already been mentioned, the Royal Western Yacht Club admitted the visitors to its privileges during their stay in Plymouth, and private individuals vied with one another in providing entertainment for their guests. The hearty goodwill which the undertaking of the Association has evoked cannot but be considered as an earnest of its future success.

Report of the Resident Superintendent, 5th December, 1887.

To the Council of the Marine Biological Association.

Gentlemen,—I beg to report to you that after finishing in the middle of January, 1887, the "Preliminary Report on the Fishing Industry of Plymouth," printed in the first number of the Journal of the Association, my attention was directed to the preparation of a series of Statistics connected with the Fishing Industry.

This work occupied me until the middle of March, from which time, until the end of July, I was engaged in drawing up a "Preliminary Report of the Fauna and Flora of the Sound."

A short résumé of these Reports is given below, *vide* Reports No. 1, No. 4, and No. 14.

During the early months of the year I examined various salt-water ponds, situated either along the Hamoaze or the Cattewater, in order to make arrangements to put live soles into the one which appeared to me to be the most suitable.

The first fortnight in May I spent in a trawling smack, and obtained live soles, and placed them in a pond into which the tide flows from the Cattewater. (*Vide* Report No. 12.) Unfortunately the means of keeping the fish in the pond, although it appeared satisfactory, was not so, and the fish have escaped.

Further, during May, June, and July, I examined soles from time to time, recording the contents of their stomachs and the condition of their sexual organs.

From the limited number of fish examined by me I am led to believe that the proportion of males to females is about as 5 to 14; but possibly the proportion is greater than this,

for owing to the immature condition of some fish I was unable to satisfy myself of their sex. I also commenced inquiries as to the movements, breeding grounds, and times of breeding of this fish along the coast; but upon the arrival of Mr. Cunningham with instructions to work at these matters I discontinued my observations.

During the whole of the year, but chiefly since March, I have been from time to time engaged in collecting specimens, either along the shore or by trawling, dredging, or surface netting; owing, however, to constant interruptions necessitated by my various other duties, this work has not been regularly followed. I have nevertheless made myself acquainted with the characteristic features of the Fauna in various localities within the Sound, and along the coast on the east side to the river Yealm, and on the west side to the middle of Whitsand Bay, while my journeys in trawling vessels have enabled me to obtain a fair knowledge of the character of the fishing grounds frequented by the Plymouth trawlers, and of the work of these fishermen. The elaboration of a scheme for the systematic recording of species collected has also had my attention. (*Vide* Appendix.)

The work of the Assistant Secretary has been carried on by me during the year, and has almost daily occupied a considerable portion of my time. The formation of a Library has been a subject of consideration, and I have been successful in obtaining from the Canadian, Danish, Dutch, French, German, Japanese, Norwegian, and United States Governments expression of their willingness to exchange their publications upon fisheries, &c., for the publications of the Association, and, indeed, with the exception of the Danish and Japanese, all these Governments have forwarded a considerable number of their Reports for past years.

The Trustees of the Australian Museum, Sydney, have forwarded a parcel of catalogues, and signified their wish to exchange publications. The Trustees of the British Museum have sent the Association a considerable number of their catalogues on natural history subjects, and the Radcliffe Library, catalogues of their natural science books from 1872—1886. The Board of Trade has sent a small selection

of blue books, and the following gentlemen and publishing firms have presented copies of books or papers.

Dr. Anderson, The Right Hon. Arthur Balfour, Mr. C. Spence Bate, Messrs. R. Bentley and Son, Messrs. Cassell and Co., Messrs. J. and A. Churchill, the Committee for the Investigation of the Fauna of the 100 fathom line off the south-west of Ireland, Mr. Doidge, Prof. Haddon, Dr. Meyer, Prof. Mitsukuri, Dr. Minot, Mr. Parfitt, and Mr. Whitley.

Arrangements for forwarding the work of Mr. Cunningham, who arrived here early in August, and Mr. Weldon, who came in November, have been regularly attended to by me. The matter of obtaining a satisfactory fisherman as servant to the Association has had my attention since I arrived here, and when Mr. Cunningham came I represented the advisability of having a man at once, and have engaged on trial William Roach. He is a married man, thirty-four years of age, works most willingly, has abundant energy, and is, in my opinion, a most intelligent man, and likely to be a very valuable servant to the Association. He is paid twenty-five shillings a week while on trial, time being given him to look after his own business, on the understanding that he should receive thirty shillings a week if permanently engaged, and that then his whole time should be at the disposal of the Association.

Matters concerned with the building of the Laboratory and with the land, the fittings, gas and water supply, &c., have entailed continually consultations and work.

With regard to the building, I have to report the stone-work is practically finished, and the roof is on. The windows are all in, and the glass fixed everywhere except in the large laboratory. The flooring is laid throughout, except in the laboratory, tank room, cellars, and the ground floor of the east wing. The engine beds are laid and the concrete floor of the engine room is finished.

Plastering, painting, and joiners' work is in progress throughout the building.

The circulating reservoirs are finished, and the tanks are in course of erection.

The pumps are all fixed, and the gas engines have arrived. The heating apparatus has been put in, and is now in use

daily. The fittings of the laboratory, library, and chemical rooms are in progress.

Temporary trestle tables have been put up in the small work-room on the second floor of the west end and in the library, and these rooms are now occupied by Mr. Cunningham and Mr. Weldon.

The concrete walls of the main reservoirs are done; the subway to the sea and the excavation for ejector are in progress.

A considerable amount of rock, &c., has still to be removed in order to completely clear the ground allotted to the Association, and when this is done the levelling of the remainder of the ground will be proceeded with.

I have been engaged during the year in drawing up various reports, and beg to conclude this report with a list of these, together with a short account of the subject of each.

1. "Preliminary Report upon the Fishing Industry of Plymouth." This report being printed in the first number of the Journal of the Association, I will not allude to it further here.

2. "Report of the work done by me up to Christmas, 1886." This report was forwarded to you when the "Preliminary Report" (No. 1 above) was presented. The nature of the difficulties I had encountered in the preparation of the Report on the Fishing Industry were mentioned, and the progress made in the investigation of the Fauna and Flora of the Sound during the first six months of my residence was noted; an account of the manner in which my time had been spent was then placed before you, and the report concluded with

3. "Report upon a plan of work to be carried out by the Association." This was briefly as follows:

A. That a diagram should be prepared showing the relation of the weather to the products of the Plymouth fishery, and the financial relations of capital, expenditure, and profit in certain instances.

B. That an experiment of putting live soles into a pond of salt water, which had been placed at the disposal of the Association for that purpose by Mr. Thomas Bulteel, of Radford, should be proceeded with.

c. That endeavours should be made to induce fishermen of this port and the neighbourhood, both trawlers, hookers, and drift fishermen, to assist the work of the Association, by recording daily details of the ground fished and the fish caught. The outline of a plan for this work was suggested, and it was urged that the information so gained should be published regularly in the Journal of the Association, and the opinion expressed that these results, when considered in relation to weather reports of the district, would be likely to throw much light upon the movements of fish, especially of non-migratory fish.

d. That a similar experiment should be carried on in Plymouth Sound, in order to compare the results obtained from the larger area outside the Sound with those obtained within the Sound, it being suggested that thus some idea might be gained of the influence of sewage and of traffic, &c., upon the movements of both migratory and non-migratory fish.

e. That certain persons in Plymouth and the neighbourhood, having recognised qualifications, should be requested, and in certain instances employed, to write accounts of what they know about fishes and the fishery of this district.

f. That investigations upon the Fauna and Flora of the Sound, and of the Fishing Industry of the district, should be continued.

g. That experiments should be made upon preserving and curing squid for bait.

h. That the Admiralty should be approached with a view to the lending of dredging and other instruments used in the 'Challenger' expedition.

4. "Statistical Report upon the Fishing Industry of Plymouth." This report was divided into six sections and contained statistics of the following subjects:

a. Statistics of fresh fish landed in Plymouth. Tables were given of the quantities and value of—

(1) White fish
(2) Crustacea and mollusca } landed at Plymouth from July, 1885, to June, 1886;

and also Tables showing the value of fish landed at Plymouth from—

(3) A trawling vessel } from July, 1884, to
(4) A hooking vessel } June, 1886.

Tables 3 and 4 showed the value of the daily catch of the different kinds of fish caught by these boats. The total value of fish landed was estimated, and the amount of money earned by the boats, and the profits made by the owners, was calculated.

B. Statistics of the carriage of fish. Tables were given of the quantities of fish despatched by rail from Plymouth at various times from 1859 to 1885, and these amounts compared with those of other fishing ports of England. Tables were also given of the railway rates charged from Plymouth and other ports.

C. Statistics of fish exported from and imported to Plymouth.

D. The local consumption of fish was estimated.

E. Statistics of fishing boats owned in Plymouth at various dates (1833—1886), giving the number of boats, their tonnage and price.

F. Statistics of persons employed in the fish trade in Plymouth. The Report concluded with a list of published and unpublished documents referred to.

5. "Report upon the best method of pumping water from the sea to the main reservoirs." Details of the cost of ten different methods were given and the advantages of each were laid before you.

6. "Report upon the best kind of pipes to be used for carrying water from the sea to the main reservoirs." Information was received from seven of the principal foreign aquariums upon this subject, and was laid before you, together with an account of experiments which had been carried on by myself for two months. Estimates of the price of five

different kinds of pipes were given and the advantages of each discussed.

7. "Details of the fittings of various rooms in the Laboratory."

8. "Details of the water supply throughout the building."

9. "Details of the gas supply throughout the building." These three reports were accompanied by sketches of furniture and plans of the rooms concerned.

10. "Report upon the duties of the Superintendent." This report set forth my opinion that—

A. The Superintendent should organise and direct the working of the Laboratory, and—

B. That he should be responsible to the Council for the management of the Association in Plymouth.

C. That he should organise and superintend the collection of specimens for the museum for the students working in the Laboratory and for correspondents.

D. That he should officiate as Librarian.

E. That he should manage monetary matters in Plymouth.

F. That he should control the servants of the Association in Plymouth. It was then urged that the duties of the Superintendent, if he was a man who had the welfare of the Association at heart, would continually be on the increase (as, for instance, the daily recording of the observations of say twelve fishermen, meteorological recording, tabulating and arranging and recording specimens, &c.), and that he should, in order to efficiently discharge his duties, be recognised by the Council as a trusted officer of the Association, and left by them to dispose of his time and to direct his work as might seem to him from day to day most advisable.

11. "Report upon the depth at which various deep-sea fisheries are conducted in various parts of the world. Haddock, Halibut, Cod, and Tile-fish fisheries were mentioned, and the depths given at which these line fisheries are conducted in different parts of the world. Trawl fisheries were then mentioned, and the depths at which this instrument is

used stated. Attention was finally drawn to surface fishing in deep water, and to drift net fishing.

12. "Report of a fortnight's work collecting soles and putting them into a pond up the Cattewater."

The result of this work was that 103 fish were placed alive in Mr. Bulteel's pond, viz.—

39 *Solea vulgaris.*
58 „ *lascaris.*
6 „ *variegata.*

13. "An account of the Laboratory of the Association." This appeared in the first number of the Journal.

14. "Preliminary Report of the Fauna and Flora of the district." This Report, which was forwarded to the Hon. Secretary in July, consists of lists of species recorded by various authorities from Plymouth or the neighbourhood, a certain number of species found by myself being also inserted.

I am, gentlemen,

Yours faithfully,

WALTER HEAPE.

APPENDIX.

In concluding this Report I beg to lay before you certain conclusions which my experience at the station has led me to believe may have reference to some of the work to be carried on in the future by the Association. The reasons which have mainly influenced me in arriving at these conclusions are:

1. The importance of treating questions of Fauna in the widest sense.

2. The necessity of collecting and systematically tabulating observations for some years, before any attempt is made to generalise from them.

3. That accurate meteorological data and statistics of marine temperature, specific gravity, &c., will be absolutely necessary before it will be possible to understand, or, indeed, to consider at all such great questions as migration, distribution, and the daily and hourly movements of animals living at the surface and in mid-water.

4. That besides the trained morphologists and zoologists, some of whom are now at work in the Laboratory, strong efforts should be made to induce such of the fishermen who are sufficiently intelligent and trustworthy to record observations.*

5. The condition of the Sound is such, artificially bounded as it is by a huge breakwater, diluted continually by two relatively large streams of fresh-water, carrying down with them sewage from Devonport, Stonehouse, Stoke, and Plymouth, and refuse from china clay works, &c.; constantly invaded and stirred up by fleets of vessels and steamers, many of them drawing thirty feet of water, when the depth of the Sound is (with the exception of some few places) not more than six fathoms, that I am of opinion that all observations of any kind whatsoever carried on in the Sound must be considered only in relation to similar observations carried on at sea and along the coast outside the Sound. Results formulated from data collected only within the Sound would, in my opinion, be entirely misleading, while, on the other hand, it would be of extreme interest to observe the effects of the streams of fresh-water, of the artificial conditions, sewage, &c., within the Sound, by comparing observations collected there with observations obtained outside the Sound.

6. That the facility of ultimate generalisation will depend upon the completeness of the system used throughout in recording observations.

A. *Scheme for recording specimens.*

1. The capture of each species should be recorded on a sheet. Whenever a specimen is obtained it should be recorded on the sheet set apart for it and the required information, data, station, depth at which it is obtained, nature of bottom, tide, wind, temperature of sea and air, density of the water, &c., recorded in the columns prepared. It would thus be seen at a glance under what con-

* I do not doubt a sufficient number of intelligent men could be obtained whose practical knowledge and independent observation would be of great help to the Association.

ditions and in what localities any species is found, the range of depth, the extremes of temperature, the nature of the ground, &c.; and the information thus tabulated could at any time be manipulated to show, for example, the different species found in any particular locality, or the effect of temperature or wind, or specific gravity of the water, &c., on any species or group of animals.

2. On small lithographed copies of the various charts, the localities and range of a species or genus or group should be indicated by coloured markings.

3. And on an enlarged Admiralty chart, on which the nature of the ground, currents, depths, &c., should be accurately shown, the *exact* position of the various "stations" where collecting work has been done should be marked.

B. *Meteorological observations, &c.*

Systematic daily meteorological records should be kept, both for Plymouth and for some point out at sea, say, the Eddystone Lighthouse. Similarly daily records of the temperature of the sea at the top and bottom, both in the Sound and out at sea should be tabulated,* while finally, observations on the specific gravity and composition of the water in the Sound and out at sea should be regularly obtained and recorded.

C. *The movements of Deep Sea Fishes.*

This, it appears to me, is one of the questions connected with the Fauna most strongly pressing for attention. It affects both the migratory and so-called non-migratory fishes. The movements of both these classes of fish are very little known, and the causes influencing their movements are, I believe, not known at all.

My intercourse with fishermen, especially with trawlers, leads me to believe that much valuable information on this

* Mr. Weldon has suggested the possibility of constructing a self-recording thermometer which could be either floated or sunk to any required depth at sea, and informs me that after consultation he has reason to believe his suggestion is perfectly feasible.

subject is to be obtained from these men ; and I would suggest the advisability of employing, say, three trawlers, three drift fishermen, and three hook-fishermen from this port, at, say, two shillings and sixpence a week each, to record the details of their daily fishing.

The information so obtained should be recorded in a tabular form, a scheme for which I am prepared to submit to you, and the knowledge so gained should point out the changes which are undoubtedly continually taking place in the nature of the bottom, even at a depth of thirty or forty fathoms, the movements of certain fish from one locality to another, the appearance or disappearance of others, their number, condition, size, time of spawning, &c. The area of observation should be extended east and west along the coast as suitable men in other districts are found to undertake the work. The mass of facts so accumulated would, in my opinion, when considered in relation to accurate records of weather, sea, temperature, &c., be of the greatest value.

D. *Local knowledge of fish.*

I would suggest that men like Mr. Dunn, of Mevagissy, Mr. Wilcock, of Plymouth, and others who are in possession of information bearing upon matters concerned with fishing and the movements of fish, information at present known only to themselves, should be invited to communicate what they know to the Journal of the Association, and in certain instances should receive payment for doing so.

E. *Bait.*

I would suggest that the question of the kind of bait it is advisable to use in " Bulter " fishing, and the supply of that bait, should be a subject of investigation by a competent man.—WALTER HEAPE.

Note.—I have not in this Appendix mentioned the work of morphologists in the Laboratory upon the development and breeding of the sole, pilchard, lobster, &c., as this work is already in progress.

Preliminary Report upon the Fauna and Flora of Plymouth Sound.

By

Walter Heape, M.A.

This Preliminary Report upon the Fauna and Flora of Plymouth Sound is almost entirely composed of lists of species which have been recorded as either actually taken in Plymouth Sound, or common to the neighbourhood.

The list of Marine Algæ is a reprint of the late Mr. T. Boswarva's catalogue, with a few additions kindly furnished me by Mr. Holmes.

Mr. C. Spence Bate has been kind enough to prepare a list of Crustacea, and is largely responsible for the information upon that group of animals contained herein.

Mr. Baker has been good enough to provide a list of the Mollusca of the Sound and neighbouring coast, which has been of great use to me; while to several fishermen I am indebted for the names of some of the rarer fishes caught in the locality.

To all these gentlemen I would now express my best thanks.

A CATALOGUE OF THE MARINE ALGÆ OF PLYMOUTH.

By Mr. J. Boswarva.

Sub-Class I.—Melanospermeæ or Fucales.
(Olive Seaweeds.)

Order I. *Fucaceæ.*

Halidrys siliquosa (Podded Halidrys). In rock-pools, and on rocks, from Mount Batten outwards, at and below half-tide level. Perennial. Winter and spring.

Cystoseira ericoides (Heath-like Cystoseira). From Bovisand outwards. Perennial. Summer.

C. granulata (Granulated Cystoseira). From Bovisand outwards. Perennial. Summer.

C. fœniculacea (Fennel-leaved Cystoseira). From Bovisand outwards. Perennial. Summer.
C. fibrosa (Fibrous Cystoseira). From Bovisand outwards. Perennial. Summer.
Pycnophycus tuberculatus (Tubercled Pycnophycus). In rock-pools, from Mount Batten outwards. Perennial. Summer and autumn.
Fucus canaliculatus (Channelled Fucus). On rocks, between high water and half-tide. Perennial. Summer and autumn.
F. nodosus (Knobbed Fucus). On rocks and large boulder stones. Perennial. Spring and summer.
F. serratus (Serrated Fucus). On rocks, half-tide level. Perennial. Winter and spring.
F. vesiculosus (Twin-bladdered Fucus). On rocks, stones, quays, &c., exposed at low water. Perennial. Summer and winter.
F. ceranoides (Horn-like Fucus). In a brackish stream, Laira embankment. Perennial. Spring and summer.
Himanthalia lorea (Leather-thong Himanthalia). Abundant on the shore. Spring and summer.

Order II. *Sporochnaceæ.*

Desmarestia aculeata (Prickly Desmarestia). On rocks on the coast, near low-water mark, and at a greater depth. Perennial.
D. ligulata (Tapering Desmarestia). On rocks on the coast, near low-water mark, and at a greater depth. Perennial.
D. viridis (Green Desmarestia). Firestone Bay; Mount Edgcumbe; low water. Annual. Spring and early summer.
Arthrocladia villosa (Hairy Arthrocladia). Sound. Annual. Summer.
Sporochnus pedunculatus (Pedunculated Sporochnus). Sound. Annual. Summer.
Carpomitra Cabreræ (Cabrera's Carpomitra). Sound. Annual. Summer.

Order III. *Laminariaceæ.*

Laminaria digitata (Fingered Laminaria). Common on rocks in deep water, and in pools. Perennial.
L. saccharina (Sugared Laminaria). Common at low-water mark, and in deep water. Perennial.
L. phyllitis. On rocks. Spring. Rare.
L. fascia (Band Laminaria). Mount Edgcumbe; Hoe; Mount Batton; and on buoys in the harbour.
Chorda filum (Thread Chorda). On rocks, stones, and in deep water. Annual. Summer and winter.
C. lomentaria (Jointed Chorda). On stones and rocks, Breakwater; Firestone Bay. Annual. Summer and autumn.

Order IV. *Dictyotaceæ.*

Cutleria multifida (Many-slit Cutleria). Dredged in the Sound, and washed on the shore. Perennial. Summer and autumn.
Haliseris polypodioides (Polypody-like Haliseris). Dredged in the Sound, and washed on the shore. Perennial. Summer and autumn.
Dictyota dichotoma (Forked Dictyota). In pools, and on rocks and stones. Annual. Summer.
Taonia atomaria (Banded Taonia). In tide-pools, and on rocks at low water. Bovisand and Whitsand Bay. Annual. Summer.
Stilophora rhizodes (Root-like Stilophora). Parasitical on algæ. Wembury Bay. Annual. Summer.
Dictyosiphon fœniculaceus (Fennel Dictyosiphon). In pools, and on rocks and stones. Torpoint. Annual. Spring and summer.
Striaria attenuata (Tapering Striaria). In pools. Firestone Bay; Trevol; Hoe. Annual. Summer.

Punctaria latifolia (Broad-leaf Punctaria). In pools, and on rocks. Mount Batten. Annual. Summer.
P. plantaginea (Plantain Punctaria). In pools, and on rocks. Mount Batten. Annual. Summer.
Asperococcus compressus (Compressed Asperococcus). In pools, and on rocks. Bovisand. Annual. Summer.
A. echinatus (Prickly Asperococcus). In pools, and on rocks. Firestone Bay; Hoe. Annual. Summer.
Litosiphon pusillus (Small Litosiphon). Parasitical on *Himanthalia lorea*. Annual. Summer.

Order V. *Chordariaceæ*.

Chordaria flagelliformis (Whip Chordaria). Cawsand; Bovisand. Annual. Summer.
Mesogloia vermicularis (Worm-like Mesogloia). Common on the coast. Annual. Summer.
M. virescens (Pale green Mesogloia). Common on the coast. Annual. Summer.
M. Griffithsiana (Mrs. Griffith's Mesogloia). In rock-pools. Annual. Summer. Rare.
Leathesia tuberiformis (Tuber-shaped Leathesia). Wembury Bay; Mewstone. Annual. Summer.
L. Berkeleyi (Berkeley's Leathesia). Wembury Bay; Mewstone. Annual. Summer.
Elachista fucicola (Fucus inhabiting Elachista). Parasitical on *Fuci*. Annual. Summer.
E. flaccida (Flaccid Elachista). Parasitical on *Cystoseira fibrosa*. Annual. Summer.
E. scutulata (Little Shield Elachista). Parasitical on *Dictyota dichotoma*. Annual. Summer.
Myrionema strangulans (Choking Myrionema). Parasitical on *Ulva* and *Enteromorpha*.

Order VI. *Ectocarpaceæ*.

Cladostephus verticillatus (Whorled Cladostephus). Common. Whitsand Bay; Mount Edgcumbe; Bovisand. Annual. Summer.
C. spongiosus (Spongy Cladostephus). Common. Hoe; Firestone Bay; Mount Edgcumbe; Bovisand. Annual. Summer.
Sphacelaria filicina (Fern-like Sphacelaria). Whitsand Bay; Mewstone; Sound. Annual. Summer.
S. scoparia (Broom Sphacelaria). Common on flat rocks. Annual. Summer.
S. plumosa (Feathery Sphacelaria). Mount Batten. Annual. Summer.
S. cirrhosa (Hair-like Sphacelaria). Rock-pools; parasitical on other algæ and corallines. Annual. Summer.
Ectocarpus siliculosus (Pod-fruited Ectocarpus). Parasitical on other algæ; sides of rocks. Summer.
E. fasciculatus (Fasciculate Ectocarpus). Parasitical on *Laminaria*. Summer.
E. Hincksiæ (Miss Hincks' Ectocarpus). Parasitical on *Laminaria*, in rock-pools. summer and autumn.
E. littoralis (Littoral Ectocarpus). Parasitical on algæ and *Zostera*, in rock-pools. Summer and autumn.
E. tessalatus (Tesselated Ectocarpus). Parasitical on algæ. Summer. Rare.
E. fenestratus (Windowed Ectocarpus). On rocks. Hoe. Annual. Summer.
E. tomentosus (Woolly Ectocarpus). Parasitical on *Fucus vesiculosus*. Common. Annual. Summer.
E. crinitus (Hairy Ectocarpus). On muddy sea-shores. Annual. Summer.
E. pusillus (Small Ectocarpus). Parasitical on small algæ. Firestone Bay. Annual. Summer.
E. granulosus (Granulous Ectocarpus). Parasitical on the smaller algæ. Common. Summer.

E. sphærophorus (Warted Ectocarpus). Parasitical on *Fuci*, at half-tide mark. Mewstone; Bovisand. Annual. Summer. Rare.
E. brachiatus (Cross-branched Ectocarpus). Parasitical on *Rhodymenia palmata*. Firestone Bay. Annual. Summer.
E. Mertensii (Mertens' Ectocarpus). In pools and on sand-covered rocks. Mount Edgcumbe; Whitsand Bay. April and May.
E. longifructus (Long-fruited Ectocarpus. On rocks. Hoe. Annual, Summer. Rare.
Myriotrichia clavæformis (Club-shaped Myriotrichia). Parasitical on *Chorda lomentaria*. Annual. Summer.
M. filiformis (Thread-like Myriotrichia). Parasitical on *Chorda lomentaria*. Annual. Summer.

Sub-Class II.—Rhodospermeæ or Ceramiales. (Red or Brown Seaweeds.)

Order VII. *Rhodomelaceæ*.

Rhodomela subfusca (Brownish Rhodomela). Common on rocks and shells between tide-marks. Perennial. Spring and summer.
Bostrychia scorpioides (Scorpioid Bostrychia). Hollows of sea-walls. Trevol; Pomfleet.
Rytiphlæa pinastroides (Pine Rytiphlæa). On rocks, low-water mark. Whitsand Bay. Perennial. Autumn and winter.
R. thuyoides (Cypress Rytiphlæa). In tide-pools, and on corallines and flat rocks. Annual. Summer.
R. fruticulosa (Shrubby Rytiphlæa). In tide-pools, and on corallines. Mount Batten; Bovisand. Perennial. Summer.
R. complanata (Compressed or flattish Rytiphlæa). On rocks at low-water mark. Bovisand.
Polysiphonia urceolata (Pitchered Polysiphonia). Very common on rocks, stones, and in pools. Annual. Spring and summer.
P. formosa (Beautiful Polysiphonia). In tide-pools, on stones. Torpoint. Annual. Summer.
P. pulvinata (Cushioned Polysiphonia). On rocks between tide-marks. Hoe; Whitsand Bay. Annual. Summer.
P. fibrata (Fibred Polysiphonia). On rocks, and in tide-pools. Mount Batten. Annual. Summer and autumn.
P. elongella (Divaricate Polysiphonia). On rocks, stones, and small algæ. Mount Edgcumbe. Biennial. Spring and summer.
P. elongata (Lobster-horn Polysiphonia). On rocks and shells, in tide-pools and deep water. Mount Batten; Mount Edgcumbe; Torpoint. Perennial. Spring and summer.
P. violacea (Violet Polysiphonia). On rocks and stones, low-water mark. Mount Edgcumbe; Bovisand. Annual. May and June.
P. fibrillosa (Fibrillose Polysiphonia). On rocks and stones, low-water mark. Mount Batten; Whitsand Bay. Annual. Summer.
P. Brodiæi (Brodie's Polysiphonia). On rocks, and in pools. Corbeal; Torpoint.
P. variegata (Variegated Polysiphonia). On mud-covered rocks. Beggar's Island; Torpoint.
P. simulans (Deceptive Polysiphonia). On rocks, and in tide-pools, low-water mark. Bovisand.
P. nigrescens (Blackish Polysiphonia). Common at half-tide mark. Perennial. Spring and summer.
P. atro-rubescens (Dark-red Polysiphonia). In pools, and on stones. Common. Annual. Spring and summer.
P. fastigiata (Level-topped Polysiphonia). On *Fuci*. Perennial. Summer and winter.

P. fœtidissima (Fetid Polysiphonia). Mount Edgcumbe. Annual. Summer.
P. parasitica (Parasitic Polysiphonia). On corallines, in pools and deep water. Firestone Bay. Annual. Summer.
P. byssoides (Byssoid Polysiphonia). On rocks and stones, near low-water mark, and in deep water. Annual. Summer.
Dasya coccinea (Scarlet Dasya). Deep water. Annual. Summer and autumn.
D. ocellata (Ocellated Dasya). On mud-covered rocks. Beggar's Island; Torpoint. Annual. Summer.
D. arbuscula (Shrub Dasya). On rocks, low-water mark. Mewstone; Mount Edgcumbe. Annual. Summer.

Order VIII. *Laurenciaceæ.*

Bonnemaisonia asparagoides (Asparagus-like Bonnemaisonia). Sound, and washed on shore. Annual. June to September.
Laurencia pinnatifida (Pinnatifid Laurencia). Abundant on rocks.
L. cæspitosa (Tufted Laurencia). On stones and rocks. Wembury Bay. Annual. Summer.
L. dasyphylla—[*Chondria dasyphylla*]—(Thick-leaved Laurencia). On rocks, low-water mark. Bovisand; Mount Edgcumbe. Annual. Summer
L. obtusa (Obtuse Laurencia). On the larger algæ. Annual. Summer and autumn.
L. tenuissima—[*Chondria tenuissima*]—(Slender Laurencia). On rocks, low-water mark. Bovisand. Annual. Summer.
Chrysymenia clavellosa—[*Chylocladia clavellosa*]—(Clubbed Chrysymenia). Abundant in pools and deep water. Annual. May to September.
C. rosea—[*Chylocladia rosea*]—(Rosy Chrysymenia). In pools, and on sides of rocks. Mount Edgcumbe; Firestone Bay. January to June. Rare. Taken by J. Gatcombe.
Chylocladia ovalis—[*Lomentaria ovalis*]—(Oval-leaved Chylocladia). On rocks, deep water, and on other algæ. Mount Edgcumbe; Firestone Bay. Annual. Spring.
C. kaliformis—[*Lomentaria kaliformis*]—(Whorled Chylocladia). On rocks, deep water, and on other algæ. Mount Edgcumbe; Firestone Bay. Annual. Summer.
C. reflexa—[*Lomentaria reflexa*]—(Reflexed Chylocladia). Occasionally in tide-pools. Annual. Summer. Rare.
C. parvula—[*Champia parvula*]—(Small Chylocladia). On small algæ and corallines. Firestone Bay. Annual. Summer and autumn.
C. articulata (Jointed Chylocladia). On rocks and algæ. Annual. Spring and summer. Common.

Order IX. *Corallinaceæ.*

Corallina officinalis (Medicinal Coralline). On rocks, and in pools between tide-marks. Common. Perennial.
C. squamata (Scaled Coralline). On rocks, and in pools between tide-marks. Common. Perennial.
Jania rubens (Red Jania). On small algæ. Bovisand and Whitsand Bay. Annual. Summer.
Melobesia calcarea (Chalk Melobesia). On rocks round the coast. Perennial.
M. membranacea (Membranaceous Melobesia). On rocks round the coast. Perennial.
M. polymorpha (Many-shaped Melobesia). On rocks round the coast. Perennial.
M. pustulata (Pimpled Melobesia). On *Phylophora rubens* and other algæ. Annual. Summer.
Hildenbrandtia rubra (Red Hildenbrandtia). On smooth stones, pebbles, and deep water. At all seasons.

Order X. *Delesseriaceæ.*

Delesseria sanguinea—[*Wormskioldia sanguinea*]—(Blood-red Delesseria). In pools, sea, and on the sides of rocks. Abundant. Perennial. Spring and summer; fruiting in winter on old stems.

D. sinuosa (Sinuous Delesseria). On larger algæ, in deep water. Biennial. Autumn and winter.

D. alata (Winged Delesseria). On rocks. Bovisand; Redding Point. Biennial. Summer.

D. hypoglossum (Proliferous Delesseria). On rocks and algæ, and in deep water. Annual. Spring and summer.

D. ruscifolia (Obtuse-leaved Delesseria). Sides of rocks, and on stones. Annual. Summer and autumn.

Nitophyllum punctatum (Dotted Nitophyllum). In deep water. Mount Edgcumbe; Firestone Bay. Annual. Summer.

N. Hilliæ (Miss Hill's Nitophyllum). In deep water. Mount Edgcumbe; Mount Batten. Annual. Summer.

N. Bonnemaisoni (Bonnemaison's Nitophyllum). Mount Edgcumbe, and on the stems of *Laminaria*. Annual. Summer.

N. Gmelini (Gmelin's Nitophyllum). Mount Edgcumbe; Anthony-passage; Firestone Bay. Annual. Summer.

N. laceratum (Torn Nitophyllum). Sides of rocks, deep water. Common. Annual. Summer.

N. versicolor (Changeable Nitophyllum). Bovisand, and deep water. Annual. Summer.

Plocamium coccineum (Scarlet Plocamium). On rocks and algæ. Common. Perennial. Summer.

Order XI. *Rhodymeniaceæ.*

Stenogramme interrupta (Interrupted Stenogramme). Dredged in summer, and washed on shore at different seasons of the year. Sound. Perennial. Rare.* Taken by J. Gatcombe.

* "This very interesting plant, by far the most important addition lately made to the British Marine Flora, was discovered on the 21st October, 1846, by Dr. John Cocks, of Plymouth, among rejectamenta on the shore at Bovisand, near Plymouth. A few days subsequently it was met with in a neighbouring station by the Rev. W. S. Hore, who at the same time gathered the equally rare and curious *Carpomitra Cabrereæ;* and to the untiring perseverance of both these gentlemen, who, day by day, during the inclement month of November—in all weathers—visited the shore, and preserved every scrap of these plants which the waves threw up, we are indebted for all the British specimens which have yet been taken of the *Stenogramme*, and for all, except Miss Ball's original one, of the *Carpomitre*."—*Harvey's Phycologia Britannica*, 1851.

Rhodymenia bifida—[*Rhodophyllis bifida*]—(Cloven Rhodymenia). On sides of rocks and stones, in deep water. Annual. Summer and autumn.

R. bifida var. *cristata*—[*Euthora cristata*]—On sides of rocks and stones, in deep water. Annual. Summer and autumn.

R. laciniata [*Callophyllis laciniata*]—(Jagged Rhodymenia). On rocks and stones in the sea, and on *Laminaria*. Spring and summer.

R. ciliata [*Calliblepharis ciliata*]—(Ciliated Rhodymenia). On rocks at low-water mark, and in deep water. Annual. Summer and winter.

R. palmetta (Little-palm Rhodymenia). On rocks at low-water mark, also in pools, and on stems of *Laminaria*. Annual. Summer and autumn.

R. palmata (Dulse or Dillisk Rhodymenia). On rocks and *Laminaria*. Abundant. Perennial.

R. jubata—[*Calliblepharis jubata*]—(Cirrhose Rhodymenia). In pools, below half-tide. General. Annual. Summer.

Sphærococcus coronopifolius (Buck's-horn Sphærococcus). Sound. Summer and winter.

Gracilaria confervoides (Conferva-like Gracilaria). On rocks and stones on the shore. General. Spring to winter.

G. multipartita (Many-divided Gracilaria). On rocks and stones on the shore. Tait's Hill; Firestone Bay. Perennial. Summer and winter.

G. erecta—[*Cordylecladia erecta*]—(Erect Gracilaria). Torpoint. Perennial. Fruiting in winter.

Cystoclonium purpurascens—[old name, *Hypnea purpurascens*]—(Purple Cystoclonium). Mount Batten; Redding Point. Annual. Summer.

Order XII. *Cryptonemiaceæ.*

Grateloupia filicina (Fern-like Grateloupia). Whitsand Bay; Mount Batten Perennial. Winter and spring.

Gelidium corneum (Horny Gelidium). On rocks and in pools. General. Annual. Summer. Several varieties.

Gigartina pistillata (Pedicellate Gigartina). Whitsand Bay. Perennial. Summer and autumn. Rare.

G. acicularis (Needle-branched Gigartina). Bovisand; Redding Point. Annual. Winter. Rare.

G. mamillosa (Mamillose Gigartina). General. On rocks. Perennial. Winter and summer. *Carrigeen Moss.*

Chondrus crispus (Curled Chondrus). General. On rocks and in pools. Perennial. Spring and summer. *Carrigeen Moss.*

C. norvegicus—[*Gymnogongrus norvegicus*]—(Norwegian Chondrus). In pools; occasionally on shore-rocks. Perennial. Autumn to summer.

Phyllophora rubens (Red Phyllophora). Whitsand Bay. Perennial. Winter and spring.

P. membranifolia (Membrane-leaved Phyllophora). In rock-pools, but not frequent.

P. Brodiæi (Brodie's Phyllophora). On *Laminaria.* Whitsand Bay. Perennial. Winter and spring.

P. palmettoides (Palmetta-like Phyllophora). Whitsand Bay. Perennial. Winter and spring. Rare.

Gymnogongrus Griffithsiæ (Mrs. Griffiths's Gymnogongrus). Cawsand Bay; Mount Edgcumbe. Perennial. Autumn and winter. Rare.

G. plicatus—[*Ahnfeldtia plicata*]—(Entangled Gymnogongrus). In shallow rock-pools. Bovisand; Mount Edgcumbe. Perennial. Common.

Polyides rotundus (Round Polyides). In pools and running water. Common. Perennial. Winter and spring.

Furcellaria fastigiata (Pointed Furcellaria). Half-tide mark. Mount Batten. Perennial. Winter.

Dumontia filiformis (Thread-like Dumontia). General. Annual. Summer.

Halymenia ligulata (Strap-shaped Halymenia). Deep water. Annual. Summer.

Ginannia furcellata—[*Scinaia furcellata*]—(Forked Ginannia). Deep water, and on rocks. Whitsand Bay. Annual. Summer.

Kallymenia reniformis (Kidney-shaped Kallymenia). Deep water, and at low-water mark. Mount Edgcumbe. Perennial. Summer and autumn.

K. Dubyi—[*Schizymenia Dubyi*]—(Duby's Kallymenia), Firestone Bay; Hoe; Mount Edgcumbe; Mount Batten. Annual. Winter and spring.

Iridæa edulis—[*Schizymenia edulis*]—(Edible Iridæa). On the coast, and in deep water. General. Perennial. Autumn and winter.

Catenella Opuntia (Indian-fig Catenella). Faces of rocks. Hoe; Mount Edgcumbe. Perennial.

Naccaria Wiggii (Wigg's Naccaria). Sound. Annual. Summer. Rare.

Gloiosiphonia capillaris (Slender Gloiosiphonia). In tide pools. Mount Edgcumbe; Wembury Bay. Annual. Early summer.

Nemaleon multifidum (Many-slit Nemaleon). On rocks, at low-water mark. Cawsand Bay; Bovisand. Summer.

N. purpureum—[*Helminthocladia purpurea*]—(Purple Nemaleon). On rocks. Whitsand Bay. Annual. Summer.

Dudresnaia coccinea (Scarlet Dudresnaia). Sound. Annual. Summer. Rare.

D. divaricata—[*Helminthora divaricata*]—Divaricate Dudresnaia). Wembury Bay. Annual. Summer and autumn.

Crouania attenuata (Attenuated Crouania). On corallines and small algæ. Firestone Bay. Annual. Autumn. Very rare.

Order XIII. *Ceramiaceæ.*

Ptilota sericea—[*Ptilota elegans*]—(Silken Ptilota). On rocks, and in pools. General. Perennial. Summer and autumn. An elegant variety is sometimes found on the outer shores, which approaches very near to *Ptilota plumosa.*

Microcladia glandulosa (Glandular Microcladia). On *Rhodymenia laciniata* and *Ceramium rubrum.* Sound. Annual. From March to September. Very rare. Taken by J. Gatcombe.

Ceramium rubrum (Red Ceramium). In pools and deep water on the shores. General. Perennial. All seasons.

C. decurrens (Decurrent Ceramium). Bovisand. Annual. Autumn. Rare.

C. Deslongchampsii (Deslongchamps' Ceramium). On stones, at half-tide mark. Mount Edgcumbe. Annual. Spring.

C. diaphanum (Diaphanous Ceramium). On rocks, and in tide-pools. Bovisand; Mewstone. Annual. Summer.

C. gracillimum (Very slender Ceramium). At low-water mark. Mount Batten; Bovisand. Annual. September. Rare.

C. flabelligerum (Fan-bearing Ceramium). Parasitical on *Cladostephus spongiosus.* Hoe. Annual. Spring.

C. fastigiatum (Level-topped Ceramium). On rocks, at low-water mark. Mount Batten. Firestone Bay. Annual. Autumn and winter. Rare.

C. nodosum (Knobbed Ceramium). Washed up from deep water. Annual. Summer.

C. strictum (Straight Ceramium). On rocks, at half-tide. General. Annual. Spring and summer.

C. echionotum (Prickly Ceramium). Deep water. Bovisand; Mount Edgcumbe. Annual. Summer.

C. acanthonotum (One-spined Ceramium). On rocks. General. Annual. Spring and summer.

C. ciliatum (Ciliated Ceramium). In pools. General. Annual. Spring and summer.

Spyridia filamentosa (Filamentose Spyridia). At low-water mark. Firestone Bay; Bovisand. Annual. Summer.

Griffithsia equisetifolia (Equisetum-leaved Griffithsia). Low-water mark. Bovisand; Whitsand Bay. Perennial. Summer.

G. devoniensis (Devonshire Griffithsia). Low-water mark. Mount Edgcumbe; Torpoint; Beggar's Island. Annual. Summer.

G. corallina (Coral-like Griffithsia). On rocks, near low-water mark. Annual. Summer.

G. secundiflora (Side-fruited Griffithsia). On one rock, at low-water mark. Bovisand. Annual. Spring and summer. Very rare. First found by Rev. W. S. Hore.

G. setacea (Bristly Griffithsia). On rocks, and in pools. General. Perennial. Fruiting in winter.

Wrangelia multifida (Many-slit Wrangelia). On rocks. Mount Edgcumbe; Mount Batten; Bovisand. Annual. Summer.

W. multifida, var. *pilifera.* On rocks. Mount Edgcumbe; Mount Batten; Bovisand. Annual. Summer.

Seirospora Griffithsiana (Mrs. Griffiths's Seirospora). Sound. Summer. Annual. Very rare. Taken by J. Gatcombe.

Callithamnion Plumula (Little Feather Callithamnion). General. Annual. Spring to winter.
C. cruciatum (Crossed Callithamnion). Torpoint. Annual. Summer.
C. Turneri (Turner's Callithamnion). Bovisand. Annual. Summer.
C. barbatum (Bearded Callithamnion). Hoe. Annual. Summer.
C. pluma (Feather Callithamnion). On stems of *Laminaria*. Summer.
C. Brodiæi (Brodie's Callithamnion). Torpoint. Annual. Summer.
C. tetragonum (Four-angled Callithamnion). Bovisand. Annual. Summer.
C. brachiatum (Armed Callithamnion). On *Laminaria*. Wembury Bay.
C. tetricum (Rough Callithamnion). On sides of rocks. General. Annual. Summer.
C. Hookeri (Hooker's Callithamnion). On rocks. Hoe. Annual. Summer.
C. roseum (Rosy Callithamnion). On mud-banks and stones. Annual. Spring and summer.
C. byssoideum (Byssus-like Callithamnion). On corallines and stones. Annual. Spring.
C. polyspermum (Many-seeded Callithamnion). On *Fuci*. Mount Edgcumbe. Annual. Spring.
C. Borreri (Borrer's Callithamnion). On rocks and stones. Mount Batten; Torpoint; Anthony-passage. Annual. Summer. Rare.
C. gracillimum (Very graceful Callithamnion). Mount Batten. Annual. Autumn.
C. thuyoideum (Cypress Callithamnion). On sides of rocks. Hoe; Mount Edgcumbe. Annual. Summer.
C. corymbosum (Corymbose Callithamnion). Torpoint. Annual. Spring.
C. spongiosum—[*Callithamnion granulatum*]—(Spongy Callithamnion). Bovisand; Firestone Bay. Annual. July and August.
C. pedicellatum—[*Corynespora pedicellata*]—(Pedicellate Callithamnion). In rock-pools. Cremill; Mount Batten. Annual. Summer.
C. Rothii (Roth's Callithamnion). Bovisand Pier. Perennial. Winter.
C. floridulum (Gay Callithamnion). In pools. Hoe. Annual. Summer.
C. Daviesii (Davies' Callithamnion). Parasitical on *Ceramium rubrum*. Annual. Summer.
C. virgatulum (Little twig Callithamnion). Parasitical on *Ceramium rubrum*. Annual. Summer.

Sub-Class III.—Chlorospermæ or Confervales. (Grass-green Seaweeds.)

Order XIV. *Siphonaceæ.*

Codium Bursa (Purse Codium). One found on a buoy in Stonehouse Pool. Summer.
C. adhærens (Adhering Codium). Wembury. Annual. Summer.
C. tomentosum (Tomentose Codium). At low-water mark. Bovisand. Annual. Summer.
Bryopsis plumosa (Feathery Bryopsis). General. Seldom appearing in the same place two following years. Annual. Summer.
B. hypnoides (Hypnum-like Bryopsis). Trevol; Mount Batten. Annual. Summer and autumn.

Order XV. *Confervaceæ.*

Cladophora pellucida (Transparent Cladophora). In rock-pools, and on stones. Firestone Bay; Hoe. Annual. Spring and summer.
C. Hutchinsiæ (Miss Hutchins' Cladophora). In rock-pools, and on stones. Firestone Bay; Hoe. Annual. Spring and summer.
C. diffusa (Diffused Cladophora). In rock-pools, and on stones. Bovisand. Annual. Spring and summer.
C. gracilis (Slender Cladophora). In rock-pools, and on stones. Firestone Bay. Annual. Spring and summer.

C. refracta (Reflexed Cladophora). In rock-pools and on stones. Whitsand Bay. Annual. Spring and summer.
C. albida (Whitish Cladophora). In rock-pools, and on stones. Bovisand; Cawsand Bay. Annual. Spring and summer.
C. lanosa (Woolly Cladophora). On other algæ. Bovisand; Stoke Bay. Annual. Spring and summer.
C. uncialis (Inch Cladophora). On rocks partly embedded in sand. Bovisand. Annual. Spring and summer.
C. arcta (Straight Cladophora). On rocks. Hoe; Bovisand. Annual. Spring and summer.
C. glaucescens (Glaucous Cladophora). On rocks. Firestone Bay; Hoe. Annual. Spring and summer.
C. rupestris (Rock-inhabiting Cladophora). On rocks, and in pools. Very general. Annual. Spring and summer.
C. lætevirens (Pale green Cladophora). On rocks. Hoe; Whitsand Bay. Annual. Spring and summer.
C. flexuosa (Flexuous Cladophora). On rocks. Mount Batten. Annual. Spring and summer.
Conferva tortuosa (Twisted Conferva). On rocks around the coast. Annual. Summer.
C. melagonium (Dark green Conferva). In rock-pools. Whitsand Bay. Annual. Summer.
C. ærea (Pale green Conferva). On sand-covered rocks. Whitsand Bay. Annual. Summer.

Order XVI. *Ulvaceæ.*

Enteromorpha intestinalis (Intestinal Enteromorpha). On rocks and stones, and in rock-pools on beaches. Annual. Summer.
E. compressa (Compressed Enteromorpha). On rocks and stones, and in rock-pools on beaches. Annual. Summer.
E. Linkiana (Link's Enteromorpha). On stones, in the sand. Mount Edgcumbe. Annual. Summer.
E. erecta (Erect Enteromorpha). On rocks in the sea. Annual. Summer.
Ulva latissima (Very broad Ulva). In rock-pools, and on rocks. Annual. Summer.
U. lactuca (Lettuce Ulva). On rocks. Cawsand Bay; Bovisand. Annual. Summer.
U. Linza (Narrow Ulva). In rock-pools, and on rocks. Annual. Summer.
Porphyra laciniata (Laciniated Porphyra). On stones and rocks. Annual. Summer.
P. vulgaris (Common Porphyra). On stones and rocks. Annual. Summer.
Bangia fusco-purpurea (Brown-purple Bangia). On rocks. Summer.
B. ciliaris (Fringe-like Bangia). On rocks. Mount Batten. Summer.

Order XVII. *Oscillatoriaceæ.*

Rivularia nitida (Glossy Rivularia). On rocks. Bovisand. Annual. Summer.
Calothrix confervicola (Conferva Calothrix). On *Ceramiam rubrum*. Mount Edgcumbe. Annual. Summer.
Lyngbya majuscula (Large Lyngbya). Washed up from deep water. Mount Edgcumbe.

The following additional names of species observed by Mr. Holmes in Plymouth Sound have been kindly forwarded to me by that gentleman:

Mitophyllum venulosum. Torpoint mud bank in June.
Arthrocladia villosa. Firestone Bay only.
Sporochines pedunculata. Torpoint.
Gratelonpia dichotoma. Renny Rocks.
Nannaria Wiggii. Torpoint.

Ginnania funellata. Torpoint.
Unangelia multifida. Torpoint.
Callithannia venicolor. Torpoint.

And the following localities especially rich in seaweed mentioned by him:
Beggars Island and Rat Island, at the mouth of St. Germans River.
Treval mill pond, Hamoaze.
Renny Rocks, Wenbury Bay.
Mewstone.
Laira.
Mount Batten.
Mount Edgcumbe Beach.
Barn Pool.
Mill Bay.

The following species named in the foregoing list have other names.

RHODOSPERMEÆ.

Laurencia dasyphylla	=	Chondria dasyphylla.
L. tenuissima	=	Chondria tenuissima.
Chrysymenia clavellosa	=	Chylocladia clavellosa.
C. rosea	=	Chylocladia rosea.
Chylocladia ovalis	=	Lomentaria ovalis.
C. kaliformis	=	L. kaliformis.
C. reflexa	=	L. reflexa.
C. parvula	=	L. parvula.
Delesseria sanguinea	=	Wormskioldia sanguinea.
Rhodymenia cristata	=	Euthora cristata.
R. bifida	=	Rhodophyllis bifida.
R. laciniata	=	Callophyllis laciniata.
R. ciliata	=	Calliblepharis ciliata.
R. jubata	=	C. jubata.
Gracilaria erecta	=	Cordylecladia erecta.
Cystoclonium pupurascens	=	Hypnea purpurascens.
Chondrus norvegicus	=	Gymnogongrus norvegicus.
Gymnogongrus plicatus	=	Ahnfeldtia plicata.
Ginannia furcellata	=	Scinaia furcellata.
Kallymenia Dubyi	=	Schizymenia Dubyi.
Iridæa edulis	=	S. edulis.
Nemaleon purpureum	=	Helminthocladia purpurea.
Dudresnaia divaricata	=	Helminthora divaricata.
Ptilota sericea	=	Ptilota elegans.
Callithamnion spongiosum	=	Callithamnion granulatum.
C. pedicellatum	=	Corynespora pedicellata.
Cruoria pellita	=	Petrocelis cruenta.

PROTOZOA.

Foraminifera.

Imperforata.

Biloculina (D'Orbig.).
ringens (D'Orbig.). In the Sound and at the Eddystone.
var. carinata (D'Orbig.).
Miliolina (Will.).
trigonula (Lam.).
Spirulina (Ehren.).
foliacea (Phillips).

Perforata.

Lagena (Walk.).
vulgaris (Planci).
var. clavata (Willm.).
var. pellucida (Willm.).
var. striata (Willm.).
Entosolenia (Ehren.).
globosa (Walk.), *var.* lineata (Willm.).
marginata (Walk.), *var.* lucida (Willm.).
var. lagenoides (Willm.).
squamosa (Maton and Rackett).
Lingulina (D'Orbig.).
carinata (D'Orbig.).
Nodosaria (Lam.).
radicula (Linn.).
pyrula (D'Orbig.).
Dentalina (D'Orbig.).
subacuata (Mont.).
Cristellaria (Lam.).
calcar (Linn.).
subarcuatula (Walk.).
Polymorphina (D'Orbig.).
lactea (Adams).
var. oblonga (Brown). Near Eddystone.
var. communis (D'Orbig.).
myristiformis (Willm.). Near Eddystone.
Orbulina (D'Orbig.).
universa (D'Orbig.).
Rotallina (D'Orbig.).
becarii (Linn.). Common on oyster-shells.
oblonga (Willm.).
nitida (Willm.).
Planorbulina (D'Orbig.).
mediterranensis (D'Orbig.). Near Eddystone in abundance.
Globigerina (D'Orbig.).
bulloides (D'Orbig.).
Truncatulina (D'Orbig.).
lobatula (Walker). Attached to Sertularians in coralline zone
Bulimina (D'Orbig.).
pupoides (D'Orbig.).
var. marginata (Willm.).
var. elongata (Willm.).
scabra (Willm.).
Textularia (Defr.).
cuneiformis (D'Orbig.).
variabilis (Willm.).
Nonionina (D'Orbig.).
crassula (Walk.). Common on oysters.
jeffreysii (Willm.).
Polystomella (Lam.).
umbilicatula (Walk.) On oysters.

PORIFERA.

Calcarea.

Grantia (Flem.).
compressa (Flem.). Very common.
ciliata (Johns.).

Leucosolenia (Bow.).
botryoides (Bow.).
Leuconia (Grant).
fistulosa (Bower.). Eddystone rocks.
Clathrina.
clathrus. Under sides of rocks. Hoe. Rare. (Stewart.)

Silicea.

Pachymatisma (Bow.).
johnstonia (Bow.). Wenbury Bay. (Stewart.)
Tethea (Lam.).
lyncurium (Johns.).
Hymeniacidon (Bow.).
suberea (Bow.). Common.
carnosua (Bow.).
celata (Bow.). Stone of Cremyll beach.
medius (Bow.).
Halichondria (Flem.).
panicea (Johns.). Common.
Isodictya (Bow.).
invalida (Bow.).
lobata (Mont.).
Desmacidon (Bow.).
fruticosa (Bow.).

Keratosa.

Chalina (Grant).
montaguii (Bow.).

CŒLENTERATA.

Actinozoa.

Octactinia.

Alcyonium.
digitatum (Linn.). Common in deep water off the coast.
Gorgonia (Edw.).
verrucosa (Linn.). Common in deep water off the coast.

Hexactinia.

Actinoloba (Blainv.).
dianthus (Blainv.). In the Sound.
Sagartia (Gosse).
bellis (Gosse). Deep pools, Whitsand Bay.
miniata (Gosse). In the Sound.
rosea (Gosse). Recorded from the neighbourhood by Rogers.
ichthystoma (Gosse). Deep water.
venusta (Gosse). In the neighbourhood (Rogers).
nivea (Gosse). Crevices and rock-pools in the Sound.
sphyrodeta (Gosse). Crevices and pools at low-water mark.
pallida (Gosse). In the neighbourhood (Rogers).
viduata (Gosse). Whitsand Bay.
parasitica (Gosse). Coralline zone.
troglodytes (Gosse). In the neighbourhood (Rogers).
Adamsia (Forb.)
palliata (Johnst.). Deep water.

Anthea (Johnst.).
cereus (Johnst.). Common in Plymouth Sound.
Aiptasia (Gosse).
couchii (Gosse). In the neighbourhood (Rogers).
Actinia (Linn.).
mesembryanthemum (Ellis and Sol.). Common at low-water mark.
Bolocera (Gosse).
tuediæ (Gosse). Trawled in deep water.
Bunodes (Gosse).
gemmacea (Gosse). Common in deep pools.
ballii (Gosse). In holes in rocks at low-water.
Tealia (Gosse).
crassicornis (Gosse). Common in tide-pools.
Peachia (Gosse).
hastata (Gosse). In the neighbourhood (Rogers).
Halcampa (Gosse).
chrysanthellum (Gosse). In deep pools with sandy bottom. Whitsand Bay.
Edwardsia (Quatr.).
carnea (Gosse). In the neighbourhood (Rogers).
Cerianthus (Della Chiaje).
lloydii (Gosse). In the neighbourhood (Rogers).
Corynactis (Allm.).
viridis (Allm.). Very common and in great variety.
Zoanthus (Cuv.).
couchii (Johnston). In the neighbourhood (Rogers).
rubicornis (Houldsw.). Within the Sound in twenty fathoms.
Caryophyllia (Lam.).
smithii (Johns.). Fairly common at low-water mark on rocks in the Sound.
Balanophyllia (Wood.).
regia (Gosse). One specimen has been found in the Sound.

Hydrozoa.

Gymnoblastea.

Clava (Gmelin).
multicornis (Pallas). Between tide-marks.
Hydractinia (v. Beneden).
echinata (Flem.). On old shells.
Coryne (Gaert.).
vaginata (Ehren.). In tide-pools.
Eudendrium (Ehren.).
ramosum (Linn.). On Sertularians or alone.
capillare (Alder). In Sound.
Tubularia (Linn.).
indivisa (Linn.). Between tide-marks and in deep water.
larynx (Ellis). In rock-pools and on Sertularians from deep water.
gracilis (Harvey).
Corymorpha (Sars).
nutans (Sars.). On sand, in six fathoms. Whitsand Bay.
Syncoryne (Ehren.).
eximia (Allm.). Along the coast.
Bimeria (S. Wright).
vestita (Wright). Along the coast.
Bougainvillia (Lesson).
ramosa (v. Beneden). Along the coast.
Cladonema (Dujard.).
radiatum (Dujard.). Along the coast.

Myriothela (Sars.).
phrygia (Fabric.). Along the coast.
Clavatella (Hincks).
prolifera (Hincks). Along the coast.

Calyptoblastea.

Plumularia (Lam.).
myriophyllum (Linn.). Common in trawl refuse.
setacea (Ellis).
echinulata (Lamk.). Abundant in tide-pools.
similis (Hincks). Abundant on weed.
Sertularia (Linn.).
polyzonias (Linn.). Between tide-marks and in deep water.
gayi (Lamouroux). Trawl refuse from deep water.
rosacea (Linn.). Near Plymouth.
tamarisca (Linn.). Near Plymouth.
abietina (Linn.). Common on the coast.
argentea (Ellis and Sol.). Common on the coast.
falcata (Linn.). Common.
Antennularia (Lam.).
ramosa (Lam.). Near Plymouth. Not common.
Laomedea (Lam.).
dichotoma (Linn.). On other zoophytes.
longissima (Pallas van B.). In coralline zone.
flexuosa (Hincks). Between tide-marks.
Campanularia (Lam.).
volubilis (Linn.). In Sound in deep water.
johnstonii (Alder). Between tide-marks and in deep water.
hincksii (Alder). Between tide-marks and in deep water.
verticillata (Linn.). In coralline zone.
Calycella (Hincks).
dumosa (Flem.). Near Plymouth very fine.
fruticosa (Sars.). In Sound or neighbourhood.

ECHINODERMATA.

Crinoidea.

Antedon (Frem.).
rosacea (Linck.). Rocks of Drake's Island and off the Cobbler Buoy in the Sound (Stewart). Also rocks south-west of Eddystone in forty fathoms.

Asteroidea.

Asterias (Linn.).
rubens (Linn.).
violacea (Müll.). Trawled in shallow water.
glacialis (Linn.). In the neighbourhood (Rogers).
Asterina (Nardo).
gibbosa (Penn.). Rock-pools.
Goniaster (Ag.).
equestris (Gmel.). In the neighbourhood (Rogers).
Solaster (Forb.).
papposus (Linn.).
Porania (Gray).
pulvillus (Gray). In the Sound.
Astropecten (Linck.).
irregularis (Penn.). Sandy shores.

Cribrella (Ag.).
oculata (Penn.). Plentiful.
Luidia (Forb.).
savignii (And.). Taken off Plymouth.
sarsii (Duben and Koren). Taken off Plymouth.

Ophiuroidea.

Ophiura (Lam.).
texturata (Lam.). Sandy shores.
albida (Forb.). In the neighbourhood (Rogers).
Ophiocoma (Ag.).
neglecta (Johnston). Under stones under the Hoe (Bellamy).
filiformis (Müll.). Inside east end of breakwater (Stewart).
granulata (Link.). Off Plymouth in deep water (Bellamy).
Ophiothrix (M. Tr.).
fragilis (Müll.). Common.

Echinoidea.

Echinus (Bond).
esculentus (Penn.). In the Sound.
acutus (Lam.). In the neighbourhood (Rogers).
Echinocyamus (Leske).
pusillus (Müll.). Dredged in crevices of stone.
Spatangus (Klein).
purpureus (Müll.). Off Plymouth, occasional.
Amphidotus.
cordatus (Penn.). Very common.

Holothuroidea.

Holothuria (Linn.).
nigra (Peach). Not uncommon.
Cucumaria (Blainv.).
pentactes (Müll.) Frequent.
hyndmani (Thompson). In holes outside Breakwater.
Ocnus (Forb. and Good.).
brunneus (Forbes). Dredged in Sound. Not uncommon.
Synapta (Esch.).
digitata (Montg). On rocky shores.
Thyone (Oken).
papillosa (Müll.). In the neighbourhood (Rogers.).

VERMES.

Platyhelminthes.

Turbellaria.

Leptoplana (Hempr., Ehrenb.).
tremellaris (O. F. Müll.). Fairly numerous on seaweed, on rocks in Sound.

Nemertina.

Nemertes (Cuv.).
borlasii (Cuv.). In the neighbourhood (Rogers).
neesii (Oerst). ? Rocks. Drake's Island.
Micrura (Ehrb.).
fasciolata (Ehrb.). Trawled in the Sound.
Amphiporus (Ehrb.).
pulcher (O. F. Müll.). Rocks. Drake's Island.

Gephyrea.

Sipunculus (Linn.).
nudus (Linn.). In holes in rocks inside Breakwater.
bernhardus. In holes in rocks inside Breakwater.
Thalassema (Gaertu).
neptuni (Gaertu.). In holes in rocks outside Breakwater.

Annelida.

Hirudinea.

Pontobdella (Leach).
areolata (Leach). Recorded from the Sound.
muricata (Lam.). In the neighbourhood (Rogers).
verrucata (Grube). On skate from deep water.

Chætopoda.

Tubifex (Lam.).
lineatus (O. F. Müll.). Amongst fuci in coralline zone.
Terebella (Mont.).
conchilega (Pall.). In the neighbourhood (Rogers).
Arenicola (Lam.).
piscatorum (Lam.). Common.
Cirratulus (Lam.).
cirratus (O. F. Müll.). Plentiful in mud under stones.
tentaculatus (Mont.). Plentiful in mud under stones, Jennycliffe Bay, the Sound.
Sabella (Savig.).
species various. In the neighbourhood (Rogers).
Spio (Turton).
seticornis (Fabr.). In the neighbourhood (Rogers).
Spirorbis (Daudin.).
spirorbis (Linn.). Very common.
Serpula (Lin.).
vermicularis (Linn.). On old shells.
var. tubes solitary.
var. tubes clustered.
intricata (Linn.).
Aphrodite (Linn.).
aculeata (Linn.). Not common.
Lepidonotus (Leach, Mgn.).
squamatus (Linn.). Common.
Harmothæ (Kimb.).
umbricata (Linn.). Common.
Nereis (Cuv.).
brevimana (John.).
pelagica (Linn.). Common from low-water mark up to the mud of brackish estuaries.
viridis (John.). Common amongst seaweed on rocks in the Sound.
Heteronereis (Oerst.)
lobulata (Savig.).
longissima (Johnst.).
Glycera (Savig.).
dubia (Blain.).
Phyllodoce (Cuv.).
viridis (Linn.). Very common in old tubes of Sabella anglica.

ARTHROPODA.

Crustacea.

Brachyura.

Stenorhynchus (Lam.).
phalangium (Penn.). Common. 3—45 fathoms.
tenuirostris (Leach). Common. 6—40 fathoms.
Achaeus (Leach).
cranchii (Leach). Occasional. 6—20 fathoms.
Inachus (Fabr.).
dorsettensis (Penn.). Occasional. 5—30 fathoms.
dorhynchus (Leach).
leptorinchus (Leach).
Pisa (Leach).
gibbsii (Leach).
tetraodon (Leach). Not common. 10—20 fathoms.
Hyas (Leach).
coarctatus (Leach). 40 fathoms.
aranea (L.). Frequent. 6—40 fathoms.
Maia (Lam.).
squinado (Herbst.). Frequent. 3—8 fathoms.
Eurynome (Leach).
aspera (Leach). 4—40 fathoms.
Xantho (Leach).
florida (Leach). Rocky coast. Occasional. 6—20 fathoms.
ribulosa (Edws.). Occasional. 6—20 fathoms.
tuberculata (Conch). Frequent. 4—45 fathoms.
Cancer (Linn.).
pagurus (Linn.). Rocky coast. 0—3 fathoms.
Pilumnus (Leach).
hirtellus (Leach). 0—3 fathoms.
Primula (Leach).
denticulata (Mont.). Frequent. 4—30 fathoms.
Carcinus (Leach).
mœnas (Linn.). Common in estuaries and creeks. 0—$\frac{1}{2}$ fathom.
Portumnus (Leach).
variegatus (Leach) (latipes, Penn.).
Portunus (Leach).
puber (Linn.). Abundant in crab-pots in September.
corrugatus (Leach). Rare in Sound. 0—$\frac{1}{2}$ fathom.
arcuatus (Leach).
depurator (Leach). Occasional. 4—45 fathoms.
marmoreus (Leach). Occasional. 3—45 fathoms.
holsatus (Fabr.). Occasional.
pusillus (Leach). Occasional. 5 fathoms.
Polybius (Leach).
henslowii (Leach). Occasional in herring and other nets, or trawled.
Pinnotheres (Latr.).
pisum (Penn.). Found in mussel at Saltash.
veterum (Box). Found in Pinna. 30 fathoms.
Gonoplax (Leach).
angulata (Leach). Not uncommon. 12 fathoms.
Planes (Leach).
linnæana (Leach). Rare. Found on living turtle near French coast.

Ebalia (Leach).
pennantii (Leach). (tuberosa, Penn.) Frequent. 40 fathoms.
bryerii (Leach). Frequent. 4—45 fathoms.
cranchii (Leach). Sound. Frequent. 40—45 fathoms.
Atelecyclus (Leach).
heterodon (Leach). Occasional. 45 fathoms.
Corystes (Leach).
cassivelaunus (Leach). Common. 12 fathoms.
Thia (Leach).
polita (Leach).

Anomoura.

Pagurus (Fabr.).
bernhardus (Linn.). Very common. 0—30 fathoms.
prideauxii (Leach). Sound. Occasional. 6—45 fathoms.
cuanensis (Thomp.). Off Plymouth. Not common. 3—10 fathoms.
hyndmanni (Thomp.). Near Plymouth. Occasional. 6 fathoms.
lævis (Thomp.). Dredged off Eddystone. Occasional. 4—10 fathoms.
forbesii (Bell).
thompsonii (Bell).
ulidianus (Thomp.).
fasciatus (Bell).
dillwynii (S. Bate). Mouth of Yealm River near Plymouth. Occasionally. 6 fathoms.
Porcellana (Lam.).
platycheles (Penn.). Common. 0—3 fathoms.
longicornis (Penn.). Common. 4—40 fathoms.
Galathea (Fabr.).
squamifera (Leach.). Occasional. 12 fathoms.
dispersa (S. Bate). Common. 4—40 fathoms.
nexa (Emb.). Occasional. 40 fathoms.
andrewsii (Kinahan). Frequent. 10—45 fathoms.
bamffica (Penn.). (Rondeletii, Bell.) Common in stomach of cod-fish, or 20—30 fathoms.
digitidistans (S. Bate). 30 fathoms.
strigosa (Fabr.). Common. 0—10 fathoms.

Macroura.

Arctus (Fabr.).
arctus (Linn.). (Ursus, S. B.) Rare. 6 fathoms.
Palinurus (Fabr.).
vulgaris (Latr.). Common. 3—10 fathoms.
Homarus (Linn.).
vulgaris (Edw.). (Marinus, Fabr.). Common. 1—6 fathoms.
Callianassa (Leach).
subterranea (Leach). One specimen. 4 fathoms. Rare.
Gebia (Leach).
stellata (Mont.). Shores of Sound.
deltura (Leach).
Axia (Leach). Rare.
stirhynchus (Leach). Near Plymouth.
Crangon (Fabr.). Common.
vulgaris (Fabr.). 0—40 fathoms.
fasciatus (Risso). Occasional. 20 fathoms.
spinosus (Leach). Frequent. 6—15 fathoms.
sculptus (Bell). 20 fathoms.
trispinosus (Hailstone). Rare. 6 fathoms.

Alpheus (Fabr.).
ruber (Edw.). Not common. 30 fathoms.
affinis (Guise). Not common. 30 fathoms.
Typton (Hellar).
spongiosum (S. Bate). Rare, within sponge. 4 fathoms.
Nika (Risso).
edulis (Risso). Occasional. 30 fathoms. Rare.
Athanas (Leach).
nitescens (Mont. Leach). Off Polperro.
Hippolyte (Leach).
varians (Leach). In rock-pools, and dredged 6—10 fathoms in Sound.
cranchii (Leach). Common.
tenuirostris (S. Bate). Several specimens. 4—6 fathoms.
bartlui (S. Bate).
spirontocaris (S. Bate) (Hippolyte).
spinus (Leach). 30 fathoms.
Palæmon (Fabr.).
serratus (Penn). Common. 1—40 fathoms.
squilla (Fabr.).
leahii (Bell).
varians (Leach).
Caridion (Goës).
gordoni (Sp. Bate).

Stomatopoda.

Mysis (Latr.).
chamœleon (Thomp.). 5 fathoms.
vulgaris (Thomp.).
griffithsiæ (Bell).
Thysanopoda (Edw.).
couchii (Bell).
Cuma (Edw.).
scorpioides (Mont.).
unguiculata (S. Bate).
Vaunthomsonia (S. Bate).
edwardsii (Kröyer).
cristata (S. Bate).
Diastylis (say, Alauna, Goodsir, Bell).
rathkii (Kröyer) (rostrata, Goodsir, Bell).
Eudora (S. Bate).
truncatula (S. Bate).
Iphithöe (S. Bate) (Halia, S. Bate, White).
trispinosa (Goodsir).
Cyrianassa (S. Bate) (Venilia, S. Bate, White).
gracilis (S. Bate).
longicornis (S. Bate).
Squilla (Fabr.).
desmarestii (Risso). Rare.
Phyllosoma (Leach).
cranchii (Leach). Surface. Rare.

Amphipoda.

Talitrus (Latreille).
locusta (Linn.). Abundant in rock-pools between tide-marks.
Orchestia (Leach).
littorea (Mont.). Under Mount Batten.
deshayesii (Savig.). Under Mount Batten. Rare.
mediterranea (Costa) (lævis, S. Bate).

Allorchestes (Dana).
nilssonii (Kröyer) (Danai, S. Bate). Shores of Sound.
imbricatus (S. Bate). Holes in Breakwater.
Nicea (Nicolet) (galanthis, S. Bate).
lubbockiana (S. Bate).
Montagna (S. Bate).
monoculoides (Mont.) (Typhis monoculoides, White, Gosse).
marina (S. Bate).
alderii (S. Bate).
pollexiana (S. Bate).
Danaia (S. Bate).
dubia (S. Bate). Trawled off Plymouth.
Lysianassa (M. Edw.).
costæ (M. Edw.).
audoniniana (S. Bate). Dredged in Sound.
longicornis (Lucas). Dredged in Sound.
atlantica (Edw.) (marina, S. Bate). Dredged in Sound.
Anonyx (Kröyer).
edwardsii (Kröyer). Dredged in Sound.
minutus (Kröyer). Dredged in Sound.
holbolli (Kröyer).
ampulla (Kröyer).
denticulatus (S. Bate).
longipes (S. Bate).
obesus (S. Bate).
longicornis (S. Bate).
typica (Kröyer).
Callisoma (Hope).
crenata (S. Bate). Near Eddystone.
Ampellisca (Kröyer).
gaimardii (Kröyer) (typica, S. Bate). Dredged in Sound.
belliana (S. Bate). In Sound.
Westwoodilla (S. Bate).
cæcula (S. Bate). In trawl refuse near Eddystone.
hyalina (S. Bate). In trawl refuse near Eddystone.
Kröyera (S. Bate).
arenaria (S. Bate).
Phoxus (Kröyer).
simplex (S. Bate) (Kröyeri, S. Bate). Dredged in Sound.
plumosus (Hoböll). Dredged in Sound.
holbölli (Kröyer). Dredged in Sound.
Monoculodes (Stimp.).
stimpsoni (S. Bate). Near Plymouth.
Urothöe (Dana).
elegans (S. Bate).
Lilgeborgia (S. Bate).
pallida (S. Bate). East of Drake's Island.
Isæa (M. Edw.).
montagui (M. Edw.). In trawl refuse near Eddystone.
Iphimedia (Rathke).
obesa (Rathke). North-west of Drake's Island.
eblanæ (S. Bate).
Acanthonotus (Owen).
testudo (Mont.).
Dexamine (Leach).
loughrinii (S. Bate). 5 fathoms.
Atylus (Leach).
bispinosus (S. Bate). Whitsand Bay.
huxleyanus (S. Bate).
swammerdamii (M. Edw.). In Sound.

Pherusa (Leach).
fucicola (Edw.). On rocky shores.
Calliope (Leach).
lævinscula (Kröyer).
Leucothöe (Leach).
articulosa (Mont.). Plymouth Sound.
Lembos (S. Bate).
versiculatus (S. Bate).
danmoniensis (S. Bate).
Aöra (Kröyer). (Lalaria, Nicolet.)
gracilis (S. Bate). In trawl refuse near Eddystone.
Eurystheus (S. Bate).
tridentatus (S. Bate).
tuberculosus (S. Bate).
erythrophthalmus (S. Bate). In Sound.
Gammarella (S. Bate).
brevicaudata (M. Edw.). (Orchestiformis, S. Bate.)
Melita (Leach).
palmata (Leach). Brackish water.
gladiosa (S. Bate). Sound.
Amathia (Rathke).
sabinii (Leach). In Sound.
Grammarus (Fabr.).
locusta (Fabr.)
gracilis (Rathke).
camptolops (Leach).
longimanus (Leach).
palmatus (Mont.). (Inæquimanus, S. Bate.)
grossimanus (Mont.).
maculatus (Johns.).
marinus (Leach). Trawled off Plymouth.
Meganæra (S. Bate).
semiserrata (S. Bate). Near Mallard Buoy in Sound.
brevicaudata (S. Bate).
Bathyporeia (Lindström). (Thersites, S. Bate.)
pilosa (Lindst.).
pelagica (S. Bate).
Leucothoë (Leach).
articulosa (Mont.). In Sound.
farina (Savig.). (Procera, S. Bate.)
Microdeutopus (Costa).
anomalus (Rath.). In sponge under Hoe.
versiculatum (S. Bate). Dredged near Plymouth.
Amphithoë (Leach).
rubricator (Mont.). Dredged in Sound.
littorina (S. Bate). On shore been tide-marks.
gammaroides (S. Bate).
Melita (Leach).
obdusata (Leach) In Sound.
Mœra (Leach).
grossimana (Mont.). Frequent in Sound.
brevicaudata (S. Bate). Dredged off Plymouth.
Sunamphithöe (S. Bate).
conformata (S. Bate).
Podocerus (Leach).
falcatus (Mont.).
variegatus (Leach). Among confervæ and rock corallines.
pulchellus (Leach).
capillatus (Rath.). Trawled off Plymouth.

Cerapus.
abditus. In Sound.
Nænia (S. Bate).
tuberculosa (S. Bate). Dredged off Plymouth.
Jassa (Leach).
pelagica (Leach).
Siphonocutus (Kröyer).
whitei (Gosse).
Erichthonius (M. Edw.).
difformis (M. Edw.).
Cyrtophium (Dana).
darwinii (S. Bate).
Corophium (Latreille).
longicorne (Fabr.). In Sound.
bonellii (M. Edw.).
Chelura (Phillipi).
terebraus (Phil.). In Sound.
Hyperia (Latr.).
galba (Mont.). (Latreillii, Edw.)
fabricii (M. Edw.).
Proto (Leach).
pedata (Leach).
goodsirii (S. Bate).
Protella (Dana).
longispina (Kröyer). (Phasma.)
Caprella (Lam.).
linearis (Latr.).
pennantii (Leach).
tuberculosa (Goodsir).
lobata (Müll.). Near Plymouth.
acanthifera (M. Edw.). Drake's Island, low water, and dredged.
acutifrons (Latreille). In the neighbourhood.
hystrix (Kröyer). In the neighbourhood.
æquilibra (S. Bate). In the neigbourhood.

Isopoda.

Arcturus (Latr.). (Astacilla, Johns.)
leachia (Johns.).
longicornis (Sowerby). Off Plymouth, attached to Echinus.
Anthura (Leach).
gracilis (Mont.).
Conilera (Leach).
cylindricus (Mont.). Knap Buoy. 6 fathoms.
Tanais (M. Edw.).
dulongii (Audouin).
hirticaudatus (S. Bate).
Paratanais (Dana).
forcipatus (Lillj.). Dredged in Sound.
Apseudes (Leach).
talpa (Mont.). Dredged in Sound.
Anceus (Risso).
maxillaris (Mont.).
rapax (M. Edw.).
Pranixa (Leach). (Tem of Anceus.)
ceruleata (Mont.).
fusca (Johns.).
edwardsii (S. Bate).

Ione (Mont.).
    thoracica (Mont.)
Bopyrus (Latr.).
    squillarum (Latr.).
    hippolytes (Roth.).
Munna (Kröy.).
    kroyeri (Good).
    whiteana (S. Bate).
Jaera (Leach).
    albifrons (Leach).
    nordmanni Rath.).
Oniscoda (Latr.).
    maculosa (Leach).
    deshayesii (Lucas).
Limnoria (Leach).
    lignorum (Rath.). (Terebrans, Leach.) In wood-work in sea.
Idotea (Fabr.).
    pelagica (Leach). Eddystone.
    tricuspidata (Desm.).
    emarginata (Fabr.).
    linearis (Fabr.). Near Plymouth.
    acuminata (Leach).
    appendiculata (Risso).
    parallela (S. Bate).
Ligia (Fabr.).
    oceanica (Linn.). Abundant on shore.
Sphæroma (Latr.).
    serratum (Fabr.). Sound. Dredged.
    rugicauda (Leach).
Dynamene (Leach).
    rubra (Leach). Near Plymouth.
Cymodocea (Leach).
    truncata (Leach).
    emarginata (Leach). Mount Edgcumbe.
    montagui (Leach).
    rubra (Leach).
    viridis (Leach).
Neræa (Leach).
    bidentata (Adams). Rocky shores.
Campecopea (Leach).
    hirsuta (Mont.).
    cranchii (Leach).
Eurydice (Leach).
    pulchra (Leach).
Æga (Leach).
    bicarinata (Leach). Trawled in Sound.
    tridens (Leach).
Cirolana (Leach).
    cranchii (Leach). Knap buoy. 6 fathoms.
Rocinela (Leach).
    danmoniensis (Leach). Rare, in Sound.

*Ostracoda.**

Pontocypris.
    mytiloides (Norman).
    trigonella (Sars).
    augusta (Brady).

* The following species were dredged at 40 fathoms in the neighbourhood of the Eddystone.

Bairdia.
inflata (Norm.).
acanthigera (Brady).
Cythere.
pellucida (Baird).
tenera (Brady).
ladia (Brady).
convexa (Baird).
fusmaichica (Sars).
villosa (Sars).
emaciata (Brady).
somipunctata (Brady).
cuneiformis (Brady).
antiqua (Baird).
jonesii (Baird).
acerosa (Brady).
Eucythere.
parva (Brady).
Loxoconcha.
impressa (Baird).
guttata (Norm.).
tamarindus (Jones).
Xestoleberis.
aurantia (Baird).
Cytherura.
angulata (Brady).
cuneata (Brady).
thiata (Sars).
similis (Sars).
acuticosta (Sars),
Cytheropteron.
punctatum (Brady).
nodosum (Brady).
multiforum (Norman).
subcircinatum (Sars).
Bathocythere.
constricta (Sars).
turgida (Sars).
Pseudocythere.
caudata (Sars).
Sclerochilus.
contorus (Norman).
Paradoxostomata.
ensiforme (Brady).
abbreviatum (Sars).
Polycope.
compressa (Brady).

Cirripedia.

Alcipe (Hauc.).
lampas (Hauc.).
Balanus (Auct.).
balanoides (Linn.).
porcatus (Costa).
Pyrgoma (Leach.).
anglicum (Sowerby).
Chthamalus (Ranz.).
stellatus (Ranz.).

Lepas (Linn.).
hillii (Dar.).
anatifera (Linn.).
Scalpellum (Leach).
vulgare (Leach). Attached to Plumularia.

Pycnogonida.

Pygnogonum (Brün).
littorale (Müll). Sound; Drake's Island.

MOLLUSCA.

Lamellibranchiata.

Teredo (Sell.).
norvegica (Speng.). In submerged wood in Sound.
navalis (Linn.). In wood piles in rocks.
megotara (Haul.).
var. mionota. Drift wood in Plymouth.
malleolus (Turt.). In Plymouth.
Pholas (Linn.).
dactylus (Linn.). In stones of Breakwater (Bellamy).
striata (Linn.). In mahogany in ship-building yards.
crispata (Linn.). Bellamy records it.
parva (Penn.). Bellamy records it.
Saxicava (F. de Bell.).
arctica (F. & H.). In limestone rocks, around Sound and at Breakwater.
rugosa (Linn.). In limestone rocks, around Sound and at Breakwater.
Venerupis (Lam.).
irus (Linn.). In crevices of limestone rocks.
Mya (Linn.). —35 fathoms.
arenaria (Linn.). Common all along south coast.
truncata (Linn.). Only one specimen found.
Panopea (M. de la Groye).
plicata (Mont.). Trawl refuse off Plymouth.
Corbula (Brug.). 20—180 fathoms.
gibba (Oliv.). Probably in Sound.
Lyonsia (Turt.). 5—80 fathoms.
norvegica (Chaun.). Probably in or near Sound.
Thracia (Leach). 30—100 fathoms.
pubescens (Pult.). In Plymouth Sound.
convexa (Wood). Probably in the Sound.
papyracea (Poli.). In the Sound.
praetenuis (Pult.). Probably near Sound.
Solen (Linn.). 0—8 fathoms.
siliqua (Linn.). Abundant in Whitsand Bay, near Raeme Head.
vagina (Linn.). Probably in deep sand, Whitsand Bay.
ensis (Linn.). In Whitsand Bay.
pellucidus (Penn.). Probably in Plymouth Sound.
Solecurtis (de Blain). 15—25 fathoms.
antiquatus (Pult.). Rare in Sound. 25 fathoms.
candidus (Renier). Rare. Probably in Sound.
Ceratisolen (Forbes). 15—25 fathoms.
legumen (Linn.). Probably in Sound.
Psammobia (Lamk.).
vespertina (Chem.). Probably in Sound. Muddy sand at low water.
ferröensis (Chem.). Probably in Sound. Muddy sand at low water.
tellinella (Lamk.). In the Sound. 25 fathoms.
costulata (Turt.). Probably in the Sound in deep water.

Gastrana (Schum.).
fragilis (Linn.). Probably in the Sound.
Tellina (Linn.).
crassa (Gmel.). In the Sound. Dredged.
donacina (Linn.). Probably in the Sound in 20 fathoms.
pusilla (Phil.). Whitsand Bay, near Raeme Head. 3—85 fathoms.
tenuis (da Costa). Whitsand Bay.
fabula (Gron.). Whitsand Bay.
balthica (Linn.). In the Sound.
balaustina (Linn.). In trawl refuse from 20 fathoms off the coast.
Scrobicularia (Schum.). Low-water to 4 fathoms.
piperata (Bellon.). Common in sandy mud. Probably in estuaries of Plym and Tamar.
alba (Wood). Whitsand Bay.
prismatica (Mont.). Whitsand Bay.
Donax (Linn.). Littoral or sublittoral.
trunculus (Linn.). Whitsand Bay.
politus (Poli). Whitsand Bay.
vittatus (Da Costa). Common all along coast (Parfitt).
Amphidesma (Lam.). 20 fathoms.
castaneum (Mont.). Probably in Sound. Rare.
Mactra (Linn.). Low-water to 50 fathoms.
solida (Linn.). In the Sound and Whitsand Bay.
var. truncata (Mont.). In the Sound.
var. elliptica (Brown). In the Sound.
stultorum (Linn.). Whitsand Bay. Abundant.
subtruncata (da Costa). In the Sound.
Lutraria (Lamk.). Low-water to 25 fathoms.
elliptica (Lamk.). Whitsand Bay.
oblongata (Chem.). Probably in Sound or Whitsand Bay. Rare.
Tapes (Mühlf.). Littoral to 140 fathoms.
aureus (Gmel). Off Plymouth. 3—10 fathoms.
virgineus (Linn.). In trawl refuse. 5—35 fathoms.
pullastra (Mont.). In the Sound. 0—7 fathoms.
var. perforans. In limestone in the Sound.
decussatus (Linn.). Probably in Sound at low-water mark.
Venus (Linn.).
verucosa (Linn.). Probably in Sound. Littoral to 7 fathoms.
casina (Linn.). Probably in Sound. 12—145 fathoms.
var. reflexa (Mont.). Probably in Sound.
gallina (Linn.). In the Sound. Common 0—100 fathoms.
fasciata (Da Costa). In the Sound. Littoral to 60 fathoms.
ovata (Penn.). In the Sound. 3—100 fathoms.
chione (Linn.). In trawl refuse. Not uncommon.
exoleta (Linn.). Probably in Sound.
lincta (Pult.). Common in Sound.
Circe (Schum.).
minima (Mont.). Probably in Sound.
Lucinopsis (Forb. and Han.). 3—80 fathoms.
undata (Penn.). Whitsand Bay. Not common.
Cyprina (Lamk.).
islandica (Linn.). Probably in Sound.
Astarte (Sower.).
sulcata (da Costa). Dredged in the Sound and Whitsand Bay. 8—80 fathoms.
var. elliptica (F. and H.). In the neighbourhood (Rogers).
triangularis (Mont.). Dredged in the Sound. 5—55 fathoms.
Isocardia (Lam.).
cor (Linn.). In trawl refuse from deep water.

Cardium (Linn.). Littoral or sublittoral in general.
aculeatum (Linn.). In Plymouth Sound in deep water. Rare.
echinatum (Linn.). In the Sound in deep water. Common.
edule (Linn.). In sand or sandy mud. Estuaries of Plym and Tamar. Common.
nodosum (Turt.). Whitsand Bay, near Raeme Head. 3—80 fathoms.
fasciatum (Mont.). Whitsand Bay. 5—50 fathoms.
norvegicum (Speng.). Probably in Sound. 15—30 fathoms.
tuberculatum (Linn.). In deep water (Bellamy).
exiguum (Gmel.). Oozy ground. Probably in Sound. 13—15 fathoms.
Lucina (Brug.).
borealis (Linn.). Probably in the Sound. Low-water to 90 fathoms.
spinifera (Mont.). In the Sound. 28 fathoms.
Axinus (Sowby.)
flexuosus (Mont.). Probably in the Sound.
Loripes (Poli.).
lacteus (Linn.). Probably in the Sound.
Diplodonta (Brown).
rotundata (Mont.). Found dead in Sound in 22 fathoms.
Cyamium (Phil.).
minutum (O. Fabr.). Whitsand Bay. Between tide-marks.
Kellia (Turt.). Low-water to 60 fathoms.
suborbicularis (Mont.). Probably in Sound.
Lasæa (Leach).
rubra (Mont.). Whitsand Bay.
Lepton (Turt.).
squamosum (Mont.). In the Sound in 22 fathoms.
clarkiæ (Clark). In the Sound. 18—80 fathoms.
Galeomma (Turt.).
turtoni (Ed. of 'Zool. Journl.'). Probably in Sound. 3—4 fathoms.
Mytilus (Linn.).
edulis (Linn.). In the Sound and estuaries. Abundant. Generally littoral.
modiolus (Linn.). In the Sound.
adriaticus (Lam.). Probably in the Sound.
barbatus (Linn.). Probably in the Sound. Rare.
Modiolaria (Beck).
discors (Linn.). On roots of laminaria (Parfitt).
marmorata (Forbes). Probably in Sound, embedded in Tunicata.
costulata (Risso). Probably in Sound, low-water mark. Rare.
Crenella (Brown).
rhombea (Berk.). Probably in Sound. 20 fathoms. Rare.
Nucula (Lam.).
nucleus (Linn.). Probably in Sound, 7—90 fathoms.
var. radiata (F. & H.). Probably in Sound. 7—25 fathoms.
Arca (Linn.).
tetragona (Poli.). In crevices in rocks. Hamoaze.
lactea (Linn.). Whitsand Bay. 7—27 fathoms.
Pectunculus (Lam.).
glycymeris (Linn.). In Sound. 15—25 fathoms.
Avicula (Klein).
hirundo (Linn.). In trawl refuse from offing.
Pinna (Lister).
rudis (Linn.). In trawl refuse from deep water.
Lima (Brug.).
subauriculata (Mont.). In Sound. 25 fathoms. Whitsand Bay. 15—50 fathoms. Rare.
loscombii (Sowerby). Probably in Sound. Low-water to 50 fathoms.
hians (Gmelin). Probably in Sound. Low-water to 50 fathoms.
Ostrea (Linn.).
edulis (Linn.). Cattewater. Prince Rock. Hamoaze.

Pecten (Pliny).
varius (Linn.). Probably in Sound. 3—35 fathoms.
pusio (Linn.). Probably in Sound. Low-water to 90 fathoms.
tigrinus (Müll.). From stomachs of flat-fish in Sound. 12—60 fathoms.
similis (Laskey). In Sound. 2—60 fathoms.
maximus (Linn.). In Sound.
opercularis (Linn.). In Sound.
var. lineata. In Sound.
var. tumida. In Sound.
Anomia (Linn.). Low-water to 30 and up to 100 fathoms.
ephippium (Linn.). In the Sound. Free or attached to Pinna.
var. aculeata. In the Sound. Attached to corallines.
patelliformis (Linn.). 15 fathoms.

Scaphopoda.

Dentalium (Linn.).
entalis (Linn.). In Sound, and from hake's stomachs.
tarentinum (Lamk.). In Sound, 12—15 fathoms, and 5 to 6 miles from land 7—25 fathoms.

Gasteropoda.

Chiton (Linn.).
hanleyi (Bean). In trawl refuse.
fascicularis (Linn.). Whitsand Bay. Littoral to 25 fathoms in deep water (Bellamy).
ruber (Linn.). Probably in the Sound.
cinereus (Linn.). In Millbay, low spring tide.
cancellatus (Sow.). Probably in Sound.
marginatus (Penn.). Doubtless in Sound.
Patella (List.). Littoral and laminarian zones.
vulgata (Linn.). In the Sound. "Rock limpet."
var. 1, elevata. In Sound.
var. 2, picta. In Sound.
var. 3, intermedia. In Sound.
var. 4, depressa (Penn.). In Sound.
var. 5, cerulea (Linn.). In Sound.
Helcion (De Mont.).
pellucidum (Linn.).
var. lœvis. In Sound.
Tectura (Cuv.).
virginea (Müll.). In Sound. "Sea-weed limpet."
Calyptræa (Lamk.).
chinensis (Linn.). In Sound. 7—10 fathoms.
Fissurella (Brug.).
græca (Linn.). Probably in Sound.
Emarginula (Lamk.).
fissura (Linn.). In Sound, in deep water.
rosea (Bell). In Sound. 20—25 fathoms.
Haliotis (Linn.).
tuberculata (Linn.). In the neighbourhood (Rogers).
Trochus (Rond.).
zizyphinus (Linn.). Common in Sound.
var. 1. Common in Sound.
var. 2. Common in Sound.
var. 3. Common in Sound.
granulatus (Born). In Sound.
exasperatus (Penn.). Probably in Sound.
millegranus (Phil.). Probably in Sound.

striatus (Linn.). Probably in Sound.
montacuti (Wood). Probably in Sound.
tumidus (Mont.). In Sound. Coralline zone. 7—80 fathoms.
cinerarius (Linn.). In Sound. Abundant. Sub-littoral.
umbilicatus (Mont.). In Sound. Abundant. Sub-littoral.
magus (Linn.). Probably in Sound. 10—15 fathoms.
lineatus (Da Costa). Probably in Sound. Between tide-marks.
Cyclostrema (Marr.). Probably in Sound. 10—40 fathoms.
cutlerianum (Clark). Probably in Sound. Found both east and west of Plymouth.
serpuloïdes (Mont.). Probably in Sound.
Phasianella (Lamk.).
pulla (Linn.). In Sound and Whitsand Bay.
Ianthina (Bolt.).
rotundata (Leach). Whitsand Bay.
exigua (Lamk.). Cast up in Whitsand Bay during storms. Not British.
Crepidula (Lamk.).
plana (Say). Dredged in the Sound.
Truncatella (Risso).
truncatula (Drap.). Under stones between tide-marks in Sound.
Rissoa (Frém.).
costata (Adams). Whitsand Bay.
parva (Da Costa). Whitsand Bay.
fulgida (Adams). Whitsand Bay.
reticulata (Mont.). On south coast, Devon.
soluta (Phil.). In Sound.
cingillus (Mont.). In Sound.
calathus (F. and H.). Whitsand Bay.
punctura (Mont.). Whitsand Bay.
inconspicua (Ald.). Trawl refuse in Plymouth.
membranacea (Adams). Plentiful on south coast, Devon.
proxima (Ald.). In sound.
vitrea (Mont.). Whitsand Bay.
violacea (Desm.). Probably in Sound.
striata (Adams). Probably in Sound.
Barleeia (Clark).
rubra (Mont.). Whitsand Bay.
Hydrobia.
ulvæ (Penn.). Doubtless in estuaries of Sound.
Lacuna (Turt).
pallidula (Da Costa). On oar-stone.
divaricata (Fabr.). Probably in Sound.
puteolus (Turt). Probably in Sound.
Skenea (Flem.).
planorbis (Fabr.). Doubtless in Sound.
Littorina (Feruss.).
litorea (Linn.). In the Sound and its estuaries.
rudis (Mat.). In the Sound and its estuaries.
var. tenebrosa. Probably in the Sound.
var. patula. On Eddystone Rocks.
obtusata (Linn.). In the Sound and its estuaries.
neritoides (Linn.). In the Sound and its estuaries.
Scalaria (Lamk.).
communis (Lamk.). In the Sound and Hamoaze.
clathratula (Adams). On roots of Corallina officinalis.
trevelyana (Leach). in the Sound.
turtonæ (Turton). Coralline zone.
Cæcum (Flem.).
trachea (Mont.). Probably off Sound. Coralline zone.
glabrum (Mont.). Probably off Sound. Coralline zone.

Turritella (Lamk.).
terebra (Linn.).
var. nivea. In Mill Bay. Low spring tide.
var. gracilis. In Mill Bay. Low spring tide.
Aclis (Lovén).
ascaris (Turt.). In Sound.
supranitida (Wood). In Sound.
gulsonæ (Clark). Probably in Sound.
unica (Mont.) Probably in Sound.
Aporrhais (Da Costa).
pes-pelecani (Linn.). Shores of Mount Edgcumbe. Low-water.
Cerithium (Adan.).
reticulatum (Da Costa). Probably in Sound.
perversum (Linn.). Probably in Sound.
Cerithiopsis (F. and H.).
pulchella (Jeff.). Coraline zone. Sound.
tubercularis (Mont.). Probably in Sound.
barleei (Jeff.). Among trawl refuse. Plymouth.
Stilifer (Brod.).
turtoni (Brod.). Attached to Echinus miliaris (Stewart).
Eulima (Risso).
polita (Linn.). Probably in Sound.
intermedia (Cantr.). Off Plymouth.
distorta (Deshay.). Probably in Sound.
subulata (Don.). Probably in Sound. Coralline zone.
Odostomia (Flem.).
truncatula (Jeff.). In trawl refuse from off Plymouth.
clavula (Lov.). Rare. Dredged Plymouth. 6—50 fathoms.
lukisi (Jeff.). Among weeds at low-water.
pallida (Mont.). In trawl refuse from off Plymouth.
conoïdea (Brocchi). Probably in Sound.
acuta (Jeff.). Coralline zone, probably in Sound.
rufa (Phil.). In trawl refuse off Plymouth.
lactea (Linn.).
insculpta (Mont.). Sand of coralline zones.
interstincta (Mont.). In Bigbury Bay.
decussata (Mont.). Probably in Sound. In coralline zone.
excavata (Phil.). Probably in Sound.
fenestrata (Forbes). Probably in Sound. Muddy ground. 7—12 fathoms.
plicata (Mont.). Probably in Sound.
rissoïdes (Hanl.). Probably in Sound.
scalaris (Phil.). Probably in Sound.
unidentata (Mont.). Probably in Sound.
Otina (Gray.).
otis (Turt.). On rocks under Hoe.
Lamellaria (Mont.).
perspicua (Linn.). Dredged in Sound.
Natica (Adan.).
catena (Da Costa). Whitsand Bay.
alderi (Forbes). Probably in Whitsand Bay.
Adeorbis (S. Wood).
subcarinatus (Mont.). Whitsand Bay. In 12 fathoms.
montacuti (Forbes). In Sound.
Cypræa (Linn.).
europæa (Mont). Common.
Ovula (Brug.).
patula (Penn.). Probably in Sound.
Marginella (Lamk.).
lævis (Don.). Probably in Sound.

Defrancia (Mill.).
leufroyi (Mich.). Probably in Sound.
teres (Forbes). Dredged. 15—85 fathoms.
gracilis (Mont.). Not uncommon on coast in coralline zone.
linearis (Mont.). Common on coast in laminarian and coralline zones and deep water.
reticulata (Ren.). In Sound. Coralline zone.
purpurea (Mont.). Doubtless at mouth of Sound.
Pleurotoma (Lamk.).
attenuata (Mont.). On coast. Coralline zone.
costata (Don.). Low-water mark in pools in Sound.
brachystoma (Phil.). On muddy sand. 10—60 fathoms.
nebula (Mont.). Common in sand, low-water.
var. elongata. In deep water.
rufa (Mont.).
var. cranchii.
striolata (Phil.). Probably off Sound.
Purpura (Brug.).
lapillus (Linn.). Common in Sound.
var. several.
Buccinum (Linn.).
undatum (Linn.). Common in Sound and estuaries.
Nassa (Lamk.).
reticulata (Linn.). In the Sound between tide-marks. Common.
incrassata (Ström.). Dredged frequently in Sound.
pygmæa (Lamk.). Coralline zone, probably in Sound.
Murex (Linn.).
erinaceus (Linn.). In the Sound.
aciculatus (Lamk.). Dredged in coralline zone. Common.
Trophon (de Mont.).
muricatus (Mont.). Muddy sand, coralline zone. On coast.
Fusus (Brug.).
antiquus (Linn.). Perhaps in Sound.
buccinatus (Lamk.). Dredged in deep water.
gracilis (da Costa). In the Sound.

Pleurobranchia.

Cylichna (Lov.).
acuminata (Brug.). In trawl refuse. Plymouth.
umbilicata (Mont.). Probably near Plymouth.
cylindracea (Penn.). Probably near Plymouth.
Utriculus (Brown). Laminarian zone.
mammillatus (Phil.). Probably near Plymouth.
trunculatus (Brug.). Doubtless at Plymouth.
Actæon (de Mont.).
tornatilis (Linn.). Whitsand Bay.
Bulla (Klein).
hydatis (Linn.). In Sound.
utriculus (Broc.). In Sound. Muddy sand.
Scaphander (De Mont.).
lignarius (Linn.). In the Sound.
Philine (Ascanius).
catena (Mont.). Probably in Sound.
punctata (Clark). Whitsand Bay.
pruinosa (Clark). Dredged off Plymouth.
aperta (Linn.). Probably Whitsand Bay.
Aplysia (Linn.).
punctata (Cuv.). Whitsand Bay. On rocks.
depilans (Linn.). Mouth of Sound. 5 fathoms.

Pleurobranchus (Cuv.).
membranaceus (Mont.). In the Sound.
plumula (Mont.). In the Sound.

Nudibranchia.

Elysia (Risso).
viridis (Mont.). In the neighbourhood (Rogers).
Eolis (Cuv.).
papillosa (Linn.). Low-water Cremill.
coronata (Forbes). In the neighbourhood (Rogers).
rufibranchialis (John.). Trawled 10 miles south-east of Plymouth.
Polycera (Cuv.).
quadrilineata (Müll.). Tide pools and Yam Gut. 4 fathoms.
Goniodoris (Forbes).
nodosa (Mont.). Fairly frequent at low-water. Under the Hoe.
Doris (Linn.).
tuberculata (Cuv.). Fairly common in Sound.
coccinea (Forbes). On shore and trawled in Sound.
testudinaria (Risso). Trawled in Sound.
Dendronotus (A. and Han).
arborescens (Müll.). Off coast.
Doto (Oken).
coronata (Gmel.). 5 miles south of Eddystone. 35 fathoms.
Limapontia (John.).
nigra (John.). On shore of Sound.

Pulmonata.

Oncidium (Buchanan).
celticum (Cuv.). Whitsand Bay. On rocks about high-water mark.

Pteropoda.

Spirialis (Eyd. and Soul.).
retroversus (Flem.). On the coast.

Cephalopoda.

Ommatostrephes (D'Orb.).
sagittatus (Lamk.). On the coast.
Loligo (Schn.).
vulgaris (Lamk.). Common in Sound and off coast.
Sepiola (Rond.).
rondeleti (Leach). In the neighbourhood (Rogers).
Sepia (Pliny).
officinalis (Linn.). Off the coast and in the Sound.
biserialis (De Mont.). Off the coast.
Octopus (Lamk.).
vulgaris (Lamk.). Along the coast.
Eledone (Leach).
cirrosa (Lamk.). In the neighbourhood (Rogers).

BRACHIOPODA.

Testicardinea.

Terebratula (Lhwyd.).
caput-serpentis (Linn.). In neighbourhood (Rogers).
Argiope (Deslong.).
capsula (Jeff.). Off Plymouth. 18—25 fathoms.

POLYZOA.

Entoprocta.

Pedicellina (Sars).
- cernua (Pallas). In tide pools on shores of Sound.
- gracilis (Sars). Common between tide-marks on coast.

Ectoprocta.

Crisia (Lamour.).
- eburnea (Linn.). On roots of laminaria all along coast.
- denticulata (Lam.). On roots of laminaria all along coast.
- cornuta (Linn.). On surface rocks along coast.

Diastopora (Lamour.).
- obelia (Johns.). On shells from deep water.
- suborbicularis (Hincks). On stones, &c. Shallow to deep water.
- patina (Lam.). On shells and stones along coast.

Lichenopora (Defr.).
- hispida (Flem.). On shells and stones from deep water.

Stomatopora (Bronn).
- deflexa (Couch). Common off Deadman.
- fungia (Couch). Common from Eddystone to Deadman.

Tubulipora (Lamk.).
- flabellaris (Fabr.). On *Pecten maximus* shells.

Idmonea (Lamx.).
- serpens (Linn.). On shells, &c., all along coast.

Alcyonidium (Lamx.).
- gelatinosum (Linn.). Common, low-water mark on coast.
- hirsutum (Flem.). On shells, low-water mark.
- mytili (Dalyell). On stones between tide-marks.

Flustrella (Gray).
- hispida (Fabr.). Common on *Fucus serratus.*

Vesicularia (Thomp.).
- spinosa (Linn.). Off the Deadman. Rare.

Amathia (Lamx.).
- lendigera (Linn.). On algæ.

Buskia (Alder).
- nitens (Alder). Obtained from the Sound.

Valkeria (Flem.)
- uva (Linn.). In shallow water, on fuci, &c.

Mimosella (Hincks).
- gracilis (Hincks). On Halidrys siliquosa.

Scrupocellaria (v. Beneden).
- scruposa (Linn.). Very common.
- reptans (Linn.). Roots of large algæ on coast.

Eucratea (Lamx.).
- chelata (Linn.). Common on large algæ.

Ætea (Lamx.).
- anguina (Linn.). Very abundant, on algæ.
- truncata (Landsb.). On shells. Not common.

Bicellaria (Blainv.).
- ciliata (Linn.). Roots of large algæ on coast. Trawled near Eddystone.

Bugula (Oken).
- turbinata (Alder). Rocks near low-water mark.
- flabellata (Thomp.). Common. From moderate to deep water.
- avicularia (Linn.). Roots of laminaria. Not common.
- calathus (Norm.). Off the coast.

Cellaria (Lamx.).
- fistulosa (Linn.). Eddystone and thereabouts.
- sinuosa (Hassal). Eddystone and eastward.

Flustra (Linn.).
foliacea (Linn.). Washed ashore.
papyracea (E. and Sol.). Shallow water on coast.
Membranipora (Blainv.).
lacroixii (Aud.). Frequent.
catenularia (Jameson). Most common.
pilosa (Linn.). Very common.
membranacea (Linn.). On algæ. Abundant.
lineata (Linn.). Common between tide-marks to deep water. On weed, stone, &c.
flustroides (Hincks). Off Deadman. 60 fathoms.
dumerilii (Aud.). Abundant on shells, &c. Shallow water.
imbellis (Hincks). Off coast, east and west of Sound. 60 fathoms.
flemingii (Busk). Common on shells, &c. Shallow to deep water.
nodulosa (Hincks). Off Brixham.
Cribrilina (Gray).
punctata (Hassall). Between tide-marks.
Membraniporella (Smitt).
nitida (Johns.). Common on stones between tide-marks.
Microporella (Hincks).
ciliata (Pallas). Common, shallow and deep water.
malusii (Aud.). On the neighbouring coast.
impressa (Aud.). Off Deadman and coast to eastward.
violacea (Johns.). Off coast.
Chorizopora (Hincks).
brongniartii (Aud.). Abundant on shells, &c., in shallow water.
Schizoporella (Hincks).
unicornis (Johns.). On stones between tide-marks. Common.
spinifera (Johns.). Roots of large laminaria.
linearis (Hassal). On coast. Abundant.
hyalina (Linn.) Not scarce on coast.
Mastigophora (Hincks).
dutertrei (Aud.) Off Deadman. 60 fathoms.
Schizotheca (Hincks).
fissa (Busk). On coast and off Deadman.
Lepralia (Johns.).
pallasiana (Moll.). Abundant between tide-marks.
foliacea (E. and Sol.). On coast and near Eddystone. Common.
pertusa (Esper). On coast. Common off Deadman.
edax (Busk.). In the Sound on Turitella.
Porella (Gray).
concinna (Busk). Off Deadman.
Smittia (Hincks).
affinis (Hincks). Start Bay on a shell.
trispinosa (Johns.). Very common shallow to deep water.
Phylactella (Hincks).
eximia (Hincks). Off Deadman.
Mucronella (Hincks).
variolosa (Johns.). Off Deadman. 60 fathoms.
coccinea (Abild.). Common littoral.
Palmicellaria (Alder),
skenei (E. and Sol.). Off Deadman. Rare.
Rhyncopora (Hincks.).
bispinosa (Johns.). Off Deadman. 60 fathoms.
Cellepora (Fabr.).
pumicosa (Linn.). Common, encrusting old shells, &c.
avicularis (Hincks). Common on Sertularians at moderate to great depths.
costazii (Aud.). On Anomia.

TUNICATA.

Ascidiæ simplices.

Ascidia (Linn.).
intestinalis (Linn.) Common in Sound.
virginea (O. F. Müll.). Not abundant in Sound.
aspera (O. F. Müll.). Not abundant in Sound.
vitrea.? In the neighbourhood (Rogers).
Molgula (Forb.).
occulata (Kupff). Dredged in Sound.
Perophora (Wiegm.).
listeri (Wiegm.). Abundant.
Cynthia (Sav.).
? On rocks in plenty.
quadrangularis. ? In the neighbourhood (Rogers).
Clavelina (Sav.).
lepadiformis (O. F. Müll.). In the neighbourhood (Rogers).

Ascidiæ compositæ.

Polycyclus.
savignyi (Herdm.).
Botryllus (Gärtn.). Everywhere.
violaceus (M. Edwards).
rubrum (M. Edwards).
Botrylloides (Edw.). Everywhere.
Leptoclinum (Edw.). On shores of Sound.
Distoma (Gärtn.). Very common.
Polyclinum (Sav.). Very common.

PISCES.

Cyclostomata.

Petromyzon (Artedi).
marinus (Linn.).
fluviatilis (Linn.). Mud of Sound and rivers.

Chondropterygii.

Ganoidei.

Accipenser (Artedi).
sturio (Linn.). Sturgeon. A few caught each year.

Elasmobranchii.

Carcharias (Müll. and H.).
glaucus (Cuv.). Blue shark. Taken in the Sound.
Mustelus (Cuv.).
vulgaris (Müll. and H.). Smooth, hound. Frequent.
Galeus (Cuv.).
vulgaris (Flem.). Tope. Common.
Lamna (Cuv.).
cornubica (Cuv.). Porbeagle. In drift nets occasionally.
Alopias (Rafin.).
vulpes (Bonap.). Thrasher. Off the coast, occasional.
Selache (Cuv.).
maxima (Cuv.). Basking shark. Off the coast occasionally.

Scyllium (Cuv.).
canicula (Cuv.). Small-spotted dog-fish. Common.
catulus (Cuv.). Nurse-hound. Common.
Acanthias (Risso).
vulgaris (Risso). Picked dog-fish. Very common.
Echinorhinus (Blainv.).
spinosus (Blainv.). Spinous shark. Taken off Plymouth.
Rhina (Klein).
squatina (Raf.). Monk-fish. Common in deep water and in Sound.
Torpedo (Duméril).
nobiliana (Bonap.). Torpedo. Rare, taken in Sound.
Raia (Art.).
batis (Linn.). Skate. Very common.
alba (Lacép.). Bordered ray. Occasional.
circularis (Couch.) Sandy ray. Common.
clavata (Linn.). Thorn-back ray. Very common.
maculata (Mont.). Spotted ray. Common.
macrorhynchus (Raf.). Flapper-skate. Has been obtained from Plymouth.
Trigon (Adanson).
pastinaca (Cuv.). Sting-ray. Taken in the Sound.
Myliobatis (Cuv.).
aquila (Cuv.). Eagle-ray. Rare.

TELEOSTEI.

Acanthopterygii.

Labrax (Cuv.).
lupus (Cuv.). Bass.
Serranus (Cuv.).
cabrilla (Cuv.). Comber. In estuaries. Not common.
Polyprion (Cuv.).
cernium (Val.). Stone-bass. Not uncommon off coast.
Mullus (Linn.).
barbatus (Linn.). Red mullet. Common.
surmuletus (Linn.). Surmullet. Estuaries. Not common.
Cantharus (Cuv. and Val.).
lineatus (Thomp.). Bream, or old-wife. Common.
Box (Cuv. and Val.).
vulgaris (Cuv. and Val.). Bogue. One recorded from near Plymouth.
Pagellus (Cuv. and Val.).
erythrinus (Cuv. and Val.). King of the breams.
centrodontus (Cuv. and Val.). Common sea-bream. Especially common.
bogaraveo (Cuv.). Spanish bream. Not common.
Trigla (Artedi).
cuculus (Linn.). Red gurnard. Common.
obscura (Linn.). Lanthorn gurnard.
lyra (Linn.). Piper.
lineata (Ginel.). Streaked gurnard.
gurnardus (Linn.). Gray gurnard. In estuaries. Common
hirundo (Linn.). Tub. Common.
Cottus (Artedi).
scorpius (Linn.). Father lasher. Common.
bubalis (Euphr.). Lucky proach. Very common on rocky coast, common also in estuaries.
Agonus (Bloch, Schneider).
cataphractus (Bl. schn.). Armed bullhead. Common in estuaries.

Peristethus (Kaup).
cataphractum (Kaup.). Armed gurnard. One taken in trawl between Plymouth and Eddystone.
Lophius (Artedi).
piscatorius (Linn.). Angler. Frequent. Reach very large size.
Trachinus (Cuv.).
draco (Linn.). Great weaver. All along coast and in offing.
vipera (Cuv. and Val.). Little weaver. All along coast; not common in estuaries.
Scomber (Artedi).
scomber (Linn.). Mackerel. Regular visitors.
Orcynus (Lütken).
thynnus (Lütken). Short-finned tunny. One specimen recorded.
Thynnus (Lütken).
pelamys (Cuv. and Val.). Bonito. One taken in Catte Water.
Centrolophus (Lacépède).
pompilus (Cuv. and Val.). Black fish. Has been taken off Penlee Point.
Caranx (Lacép.).
trachurus (Lacép.). Scad. Regular visitor.
Naucrates (Cuv.).
ductor (Cuv and Val.). Pilot fish. Two specimens recorded.
Capros (Lacép.).
aper (Lacép.). Cuckoo-fish. Common.
Zeus (Cuv.).
faber (Linn.). John Dory. Common.
Xiphias (Artedi).
gladius (Linn.). Swordfish. One specimen caught in drift net.
Sciæna (Cuv.).
aquila (Risso). Sciæna or Maigre. Off the Coast.
Trichiurus (Linn.).
lepturus (Linn.). Silvery hair tail. Caught in herring nets occasionally.
Gobius (Artedi).
niger (Linn.). Rock goby. Common.
ruthensparri (Euph.). Two-spotted goby. Abundant in Sound.
minutus (Gmel.). One-spotted goby. Common in estuaries.
Callionymus (Linn.).
lyra (Linn.). Yellow skulpin. Female plentiful in estuaries, male only in mid-channel.
Cyclopterus (Linn.).
lumpus (Linn.). Lump-fish. Fairly common.
Liparis (Artedi).
vulgaris (Flem.). Sea snail. Common.
montagui (Cuv.). Network sucker. Probably in estuaries of Sound.
Lepadogaster (Gouan).
gouanii (Lacép.). Cornish sucker. In Sound. Not common.
bimaculatus (Flem.). Doubly-spotted sucker. Not common.
Anarrhichas (Artedi).
lupus (Linn.). Wolf fish. Rare.
Blennius (Artedi).
ocellaris (Linn.). Butterfly blenny. One specimen recorded.
gattorugine (Bloch). Tompot. In Sound. Not common.
pholis (Linn.). Shanny. Common on rocky shores.
galerita (Linn). Montague's Blenny. In estuaries. Uncommon.
Centronotus (Bloch, Schn.).
gunnellus (Bloch, Schn.). Butter-fish. Abundant in Sound.
Zoarces (Cuv.).
viviparus (Cuv.). Viviparous blenny. In the neighbourhood (Rogers).
Cepola (Linn.).
rubescens (Linn.). Red band fish. Taken in Sound.

Mugil (Artedi).
capito (Cuv.). Gray mullet. Abundant in estuaries.
chelo (Cuv.). Lesser grey mullet. Abundant in estuaries.
Atherina (Artedi).
presbyter (Jenyns). Atherine. In the neighbourhood (Rogers).
Gasterosteus (Artedi).
aculeatus (Linn.).
var. trachurus (Cuv. and Val.). Rough-tailed stickleback. Common.
spinachia (Linn.). Fifteen-spined stickleback. Common in Sound.
Ctenolabrus (Cuv. and Val.).
rupestris (Cuv. and Val.). Jago's goldsinny.
Centrolabrus (Günth.).
exoletus (Günth). Rock-cook. Abundant in Sound.
Acantholabrus (Cuv. and Val.).
palloni (Cuv. and Pal.). Scale-rayed wrasse. A specimen taken off Deadman.
Coris (Lacép.).
julis (Günth). Rainbow wrasse.
Labrus (Artedi).
maculatus (Bl.). Ballan wrasse. Abundant in Sound.
mixtus (Fr. o. Ek.). Cuckoo wrasse. Not common in Sound.
lineatus (Don.). Green wrasse.
Crenilabrus (Cuv.).
melops (Cuv.). Cork wing. Abundant in Sound.
cornubicus (Risso). Goldsinny. Abundant in Sound.

Anacanthini.

Gadus (Cuv.).
morhua (Linn.). Cod. Fairly common.
æglefinus (Linn.). Haddock. Frequent.
luscus (Linn.). Bib. Very common.
merlangus (Linn.). Whiting. Very common.
minutus (Linn.). Poor-cod. Very common.
pollachius (Linn.). Pollack. Very common.
virens (Linn.). Coal-fish. Very common.
Merluccius (Cuv.).
vulgaris (Cuv.). Hake. Common.
Molva (Nil.).
vulgaris (Flem.). Ling. Common.
Motella (Cuv.).
tricirrata (Nil.). Three-bearded rockling. Abundant in estuaries.
cimbria (Nil.). Four-bearded rockling. In the neighbourhood (Rogers).
mustela (Nil.). Five-bearded rockling. In the neighbourhood (Rogers).
Raniceps (Cuv.).
raninus (Coll.) Lesser fork-beard. In the Sound.
Ammodytes (Artedi).
launceolatus (Lesauv.). Larger sand launce. Common.
tobianus (Linn.). Lesser sand launce. Common.
Hippoglossus (Cuv.).
vulgaris (Flem.). Holibut.
Rhombus (Cuv.).
maximus (Cuv). Turbot. Fairly common.
lævis (Rondel). Brill. Frequent.
Zeugopterus (Gottsche).
punctatus (Collett). Müller's topknot. Common in estuaries.
unimaculatus (Risso). Bloch's topknot.
Arnoglossus (Bleeker).
megastoma. (?) Merry sole. Common.
laterna (Günth.). Megrim. Common.

Pleuronectes (Artedi).
platessa (Linn.). Plaice. Very common.
flesus (Linn.). Flounder. Very common.
limanda (Linn.). Dab. Very common.
cynoglossus (Linn.). Craig-fluke.
microcephalus (Don.). Smear-dab. Fairly common.
Solea (Cuv.).
vulgaris (Quensel). Sole. Common.
variegata (Flem.). Thick back. Common in deep water.
lascaris (Risso). Lemon sole. Common.
lutea (Bonap.). Red sole. Taken off coast.

Physostomi.

Salmo (Artedi).
cambricus (Don.). Salmon trout. Along the coast.
fario (Linn.). Trout. Near to the mouth of the Plym.
Belone (Cuv.).
vulgaris (Flem.). Garfish. Common off coast and in the Sound.
Scombresox (Lacép.).
saurus (Flem.). Skipper. One specimen found under the Hoe.
Exocœtus (Artedi).
volitans (Linn.). Greater flying fish. Recorded in Sutton Pool.
Engraulis (Cuv.).
encrasicholus (Cuv.). Anchovy. Taken off coast in drift nets occasionally.
Clupea (Artedi).
harengus (Linn.). Herring. Regular visitor.
pilchardus (Walb.). Pilchard. Regular visitor.
sprattus (Linn.). Sprat. Very common.
alosa (Linn.). Alewife. Common.
finta (Cuv.). Twaite shad. Occasional in the estuaries.
Anguilla (Belon).
vulgaris (Turt.). Eel. In estuaries, common.
Conger (Cuv.).
vulgaris (Cuv.). Conger. Common in deep water, on rocky ground.

Lophobranchii.

Syngnathus (Artedi).
acus (Linn.). Greater pipe fish. Common.
Nerophis (Rafin.).
lumbriciformis (Kröy). Worm-pipe fish. Common on shore.

Plectognathi.

Orthagoriscus (Bl. Schn.).
mola (Bl. Schn.). Short sun-fish. Sometimes seen off coast.
truncatus (Flem.). Oblong sun-fish. Recorded off coast.

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No. 2. *Allman.*—'Monograph of Gymnoblastic Hydroids' (1872).
No. 3. *Bate and Westwood.*—'British Sessile-eyed Crustacea' (1863-8).
No. 4. *Bellamy.*—'The Natural History of South Devon' (1839).
No. 5. *Bowerbank.*—'British Spongiadæ' (1864–82).
No. 6. 'British Association Reports.'—'Reports on the Fauna of South Devon (1867, 1872).
No. 7. *Couch.*—'British Fishes' (1877).

No. 8. *Darwin.*—'Monograph of the Cirripedia' (1881-3).
No. 9. *Day.*—'British Fishes' (1880-4).
No. 10. *Forbes.*—'British Starfishes,' 1841.
No. 11. *Gosse.*—'British Sea Anemones and Corals' (1860).
No. 12. *Hincks.*—'British Marine Polyzoa' (1880).
No. 13. *Hunt.*—"Notes on Tor Bay" ('Transactions of Devon Association,' 1878).
No. 14. *Johnston.*—'Catalogue of British Non-Parasitical Worms in the Collection of the British Museum' (1865).
No. 15. *Jeffreys.*—'British Conchology' (1862).
No. 16. *McIntosh.*—'A Monograph of British Annelids' (1873-74).
No. 17. *Parfitt.*—'Catalogue of the Fauna of Devon Zoophytes,' 1866.*
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No. 25. *Parfitt.*—'Fauna of Devon. Fishes,' 1875.
No. 26. *Pennington.*—'British Zoophytes' (1885).
No. 27. *Rogers.*—List of Marine Animals for Sale.
No. 28. *Yarrel.*—'British Fishes' (1859).
No. 29. 'The Zoologist,' Oct., 1872; Jan., 1876; Sept., 1878; Aug., 1884.

* The remainder of Parfitt's papers all appear in the 'Transactions of the Devon Association.' The dates alone are mentioned.

Preliminary Inquiries at Plymouth into the Marine Fauna and the Ova of Fishes.

By J. T. Cunningham, B.A.,
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Although the Plymouth Laboratory was opened only on June 30th, investigations have been carried on by the Association for the last two years. These inquiries have necessarily been of a general and preliminary character, but they have resulted in the acquisition of definite precise information on several subjects, in which previously only conjecture or complete ignorance prevailed. This information includes discoveries of some value and completeness in themselves, but its chief importance lies in the fact that it shows in what directions and by what means the instruments of inquiry supplied by the Plymouth Laboratory, and its organisation, can be applied without delay to fruitful work. It was with just this object in view that the Council instituted these preliminary inquiries; without them, when the apparatus of the Laboratory was ready for action, the staff would have had to make tentative experiments before they knew what problems the neighbourhood of Plymouth gave the material for solving. With them the fisheries and the marine Fauna of Plymouth are mapped out, and problems to be worked out are definitely proposed, so that the tanks and the powers of the zoologists can be fully occupied without loss of time.

I will shortly describe the inquiries carried on since the beginning of August, 1887, into the local marine Fauna, and the natural history of food-fishes.

In the autumn of last year the Sound inside the Breakwater, and the neighbourhood of the coast on either side east and west, were explored generally by the dredge and small trawl. In this way it was ascertained that some

interesting forms were abundantly to be found at certain localities. Thus the Feather-star (*Antedon rosaceus*), the most interesting of British Echinodermata, lives in large numbers between the Mallard and the Cobbler Buoys, right at the door, so to speak, of the Laboratory, for the spot is but a few hundred yards from the building. A dredge put down there for two or three minutes came up half full of these beautiful and delicate creatures. Anyone wishing to pursue the study of this animal's development and physiology, subjects by no means yet exhausted, has to take very little trouble in order to procure specimens.

In other parts of the Sound only occasional specimens of the Feather-star are met with. Sponges of various species occur abundantly in the Sound, one curious species well-known to naturalists is somewhat common ; it has usually a globular or nearly globular form ; it reaches a large size, some specimens being as big as a child's head. It has a hard rind, which presents a regular reticulation on the surface. This rounded mass (*Raphyrus Griffithsii*, Bowbuk) would be taken by everyone at first sight for a sea-worn stone, and there is little doubt that it is a perfect example of what is technically called mimicry; the shape and appearance of a rounded stone having been acquired by the sponge just because it is then mistaken by predaceous animals for one of the stones among which it lies on the sea-bottom. In the interior of this sponge is always found an inorganic body, usually a piece of shell, which served as its foundation when it began to grow.

The curious pipe-fishes, which look like grotesque fishes carved out of a piece of walking stick, are also common in the Sound. These are among the very few fishes which take care of their eggs ; the male receives these when they are shed into a pouch formed by the skin beneath his tail, and there they remain while the young fish are developing, and until they are hatched and escape. Thus the male in this order has the same peculiar method of guarding his progeny as the female kangaroo in Australia.

A great number of species of marine worms live on the shores of the Sound and its estuaries. In the latter, digging

for them is unpleasant, as the mud is so soft that a man sinks in over his ankles; but there is one place in Jennycliff Bay where there is a patch of hard sand, from which they can be dug without difficulty, and many other kinds are found under the stones on the east shore of Drake's Island.

Crustacea are abundant and varied; they include the common shrimp, the red shrimp, the prawn, and many less familiar species. The development of these is being studied systematically in detail, as well as that of the lobster, crab, and "crayfish," by Mr. W. F. R. Weldon.

In Sutton Pool eels are taken at certain times of the year, and efforts are being made to throw some light on the reproduction of these, a problem whose complete solution has evaded the researches of naturalists for the last two centuries.

Passing now beyond the Sound, the thickest marine population occurs in the neighbourhood of the Mewstone. Here have been dredged numbers of large Holothurians, animals with somewhat the appearance of black puddings, a foot in length, and belonging to the same class as star-fishes and feather-stars, namely, the Echinodermata. Also beautiful sponges, feather-stars themselves, great coral-like masses of a colonial animal called *Lepralia foliacea*, in the cavities of which the feather-stars creep about, large ascidians or sea-squirts, and the pretty red fans or "sea-trees," as they are called by the fishermen, formed by the Gorgonia, one of the coral order.

On the sands off Whitsand Bay are trawled young flat-fishes and a variety of shell-fish or molluscs, including small Cephalopods, allied to the cuttle-fish. On the shores of the bay the rocks which project above the sand are covered with masses of agglomerated sand grains formed by the tubes of a small worm (Sabellaria). These masses are in many cases yards in diameter, and a foot thick, and remind one almost of coral reefs, though the mode of formation is quite different.

The food-fishes have been studied by means of excursions on fishing boats, and by the help of the fishermen. The eggs of nearly all our food-fishes except the herring are buoyant and transparent when they are ripe. The immature

eggs in the ovary are opaque, white grains, but by the time they are shed they become as transparent as glass. These ova as soon as they are shed are fertilized by milt in the water supplied by male fish in the neighbourhood, and then they rise towards the surface of the sea; in calm weather only do they actually reach the surface, because being but slightly lighter than the water agitation causes them to be uniformly distributed throughout the depth affected by the wave-motion. A fine net made of muslin, or similar material, drawn gently through the water at almost any season of the year, collects numbers of these buoyant eggs, which can be taken ashore and examined with the microscope. But as these eggs are of many different kinds, and show constant differences of structure, it is necessary to know what species of fish each kind belongs to. One way of doing this is to trace the development of the young fish after it is hatched, until it reaches an age at which it can be recognised as a whiting, sole, turbot, or other particular species. But this, although easy enough to propose, is exceedingly difficult in practice, and when followed usually leads to serious errors. There is a more certain method, and that is to take the fish when its ova are ripe, and by gentle pressure expel these into a bottle of sea-water, then to add some milt from a male of the same species, and keep the ova so obtained in healthy conditions while they develop. This process of obtaining ova is called artificial fertilization.

A number of species have been subjected by various observers in different places to this process, and the structure of the egg and young stages have been described in published papers. Thus I myself published drawings and descriptions of the ova of the cod, haddock, whiting, gurnard, smelt (*Osmerus eperlanus*), plaice, common flounder, dab, and pole flounder. But many species remained to be examined. The first ova which I artificially fertilized after arriving at Plymouth were those of *Capros aper*, a small fish with very spiny fins, known sometimes as the boar-fish, but always spoken of by Plymouth trawlers as the cuckoo. This fish is taken in the trawl occasionally at all seasons of the year, but in the latter part of summer, especially in August and

September, it is taken in the neighbourhood of the Eddystone in hundreds and thousands, so that it becomes a pest to the fishermen, as there is no market for it.

No attempt was made to follow out the development of these ova, because suitable arrangements were not available. At that time the building was in a very early stage of construction; the stairs had not yet been made, and the plasterers were everywhere at work, so that it was impossible for me to take possession of any room in which to carry on my work. I was occupying a small room in the fishermen's quarter, which I had hired a day or two after my arrival in Plymouth. This room was a short distance from the fish quay, usually known as the Barbican, and this position was its sole recommendation. It had a single window, from which the sky was invisible, as it looked into a narrow court only a few yards wide, on the other side of which were house walls pierced by other small windows.

In this room I kept alive ova of the cuckoo-fish, which I fertilized on board a trawler on August 15th, for three days, and made a few drawings of the successive stages of development. These ova belong to a type which is common to a large number of species of sea-fish. They are spherical, with a transparent, structureless yolk, in which is a single globule of oily matter. The egg-envelope is separated by only a small space from the egg itself.

At the beginning of November the Laboratory was sufficiently advanced that a room in the west wing could be so far finished that I could use it as a temporary work-room, and accordingly it was supplied with some trestle tables, and I occupied it from that time until a week before the formal opening of the building.

In November, December, and January some attention was paid to the herring. At that season there is a regular herring fishery at Plymouth, which consists of two branches, a fishery inside the Sound, which is carried on by open rowing boats working only two or three drift-nets each, and a fishery outside along the coast as far as Bolt Head, carried on by larger boats working complete "fleets" of nets. On clear, quiet, dark nights, when the herring are plentiful,

there are a very large number of small boats fishing in the Sound after sunset, and as each carries a somewhat brilliant light to prevent vessels under weigh running her down, the sight from the Hoe is very pretty, and reminds one of a Venetian fête. The herring taken are all full, *i. e.* in mature spawning condition, till towards the end of the season, when large numbers of spent fish are taken. In Cawsand Bay, on the west side of the Sound, moored nets are used to catch herring; these are of the same kind as drift nets, but are fixed by means of anchors at each end, instead of being allowed to drift with the tide.

As both full and spent herring are taken inside the Sound, it is natural to conclude that the spawn is actually deposited within that area. It is well known that herring spawn is adhesive, and attaches itself to stones and weed at the bottom of the water. Systematic dredging was therefore carried on all over the Sound in January with a view of finding some of the spawn, and so ascertaining at which spots it was deposited. But the search was entirely unsuccessful, circumstances did not allow of similar researches being carried on outside the Sound, and the question of the exact locality where the herring deposit their spawn in the neighbourhood of Plymouth remains to be answered in future seasons. Herring ova have so often been studied and described, that no special study of them was made, and no arrangements were available for hatching any. Young herring were frequently taken in the tow-nets in the months of February and March.

The ova of the common sole had, at the beginning of the present year, never been examined or described. It had been thought by some that male soles were very rarely caught, but on dissection of specimens procured from the fish-quay I found that this was not correct, and in subsequent work on the species I never had difficulty in procuring specimens of the male sex. After the beginning of February I went out frequently in trawlers on their ordinary trips for the express purpose of examining soles in a sexually ripe condition, and artificially fertilizing samples of the ova. On February 6th, I made my first examination of living soles about ten miles

west by south of the Eddystone. There were not many in the trawl, and although I got a few ripe ova, I could not press any milt from any of the fish. Accordingly, when I got ashore again I found the ova were unfertilized. Nearly all the trawlers after this time went to fish off the Wolf Rock, about thirty to forty miles west of the Lizard, remaining at sea a week on each trip. In order to pursue the study of soles' ova, I went several times with one of them in March, April, and May to this fishing ground, where soles are very much more abundant than off Plymouth. But although I frequently obtained ripe ova in considerable numbers, I could never press out ripe milt from a male. I therefore cut out the testes and cut them in pieces and placed them in the water with the ova, hoping that fertilization could be effected by this method. The expedient succeeded, but only to a slight degree, as only about a dozen ova were fertilized on each occasion out of several hundreds. These few were sufficient to show the normal character of the fertilized ova. The ovum of the sole was thus found to have several marked peculiarities, which enable it to be recognised with certainty when taken in the tow-net. It is of considerable size, and spherical in shape; instead of having a single oil globule it has a large number of very minute size, which are irregularly distributed in groups of different sizes over the surface of the ovum. The vitellus is homogeneous in the centre, but when the embryo is formed has a superficial layer of separate vitelline masses.

The ova of the merry-sole, *Pleuronectes microcephalus*, were obtained with great ease in large numbers and fertilized without difficulty. Numbers of these were hatched, although they were kept in small bottles, in which the water was changed only once a day. If it were worth while to propagate so abundant and cheap a form, it would be a simple matter to hatch millions of young merry-soles from the eggs of the parent fish caught for the market.

The eggs of two species of gurnard, *Trigla gurnardus* and *Trigla cuculus* were also fertilized, and the young fish hatched; but these were not so hardy as those of the merry-sole.

The ova of the mackerel are at present under observation.

They can be obtained and fertilized with the greatest ease, as in June and July a large proportion of every catch are ripe fish of both sexes. After explaining to Mr. F. Johns, the skipper of a mackerel boat, the necessary operations, and promising him payment for his trouble, I found he could bring me mackerel ova properly fertilized and in good condition whenever he shot his nets. The mackerel is another species which could be artificially propagated to any desired extent. The eggs of the mackerel are closely similar to those of the cuckoo-fish ; they have a single oil globule and an otherwise homogeneous yolk ; they are buoyant and transparent.

Pilchard ova have not yet been obtained. In the case of mackerel and herring the fishing season and the spawning season coincide ; in the case of the pilchard there is no fishery in the spawning season. The pilchard leaves the shore when spawning, and at that time, June and July, no shoals are met with. But spawning specimens are caught occasionally in small numbers in the mackerel nets, and it is from some so taken that I expect before long to get some fertilized ova. Now that the supply of salt water in the Laboratory is at last available, the examination and the hatching of the eggs of fish becomes comparatively easy, and it may reasonably be hoped that these preliminary results will be rapidly extended.

The St. Andrews Marine Laboratory (under the Fishery Board for Scotland).

By Prof. McIntosh, F.R.S.

Preliminary Remarks.

St. Andrews as a site for the study of marine animals has a reputation probably at least as ancient as the foundation of its University (the oldest Scottish, viz. 1411), for amongst the early records of the latter allusion is made to the marvels of the sea and its inhabitants as a means for improving the minds of its students. For a long time, however, no special lectures on natural history were given. The scientific advantages of the situation, indeed, were first prominently recognised by Edward Forbes and the brothers Goodsir. Thus the former, for instance, picked up, for the first time in Britain *Echiurus*, on the sands after a storm; and the two Goodsirs, as students, were familiar with its marine rarities, and afterwards read many zoological papers at its Literary and Philosophical Society. Prof. John Reid, the physiologist, studied the development of zoophytes and mollusks in its rock pools, and Prof. G. E. Day, his successor in the Chair of Anatomy and Physiology, and Miss Otté, lost no opportunity of interesting the students in marine zoology. Besides, the occupants of the Chair of Natural History from its foundation in 1753, and including Professors Vilant, Dick, Forrest, Cleghorn, Adamson, Ferrie, Macdonald, and Nicholson, as well as Dr. McVicar, the University lecturer, all more or less drew from the rich marine resources in their proximity.

It is long since efforts were made in the direction of founding a biological station at St. Andrews, and by one at least this has been steadily kept in view since student-days in 1853—57. On an opportunity presenting itself in the beginning of 1875 the subject was again advocated, and

it was only the accident of an election that prevented the foundation of the Marine Laboratory that year. At this time Dr. Dohrn, of the Naples Zoological Station, cordially endorsed the proposal, and alluded to the University as, by "its position near the sea, inviting more than any other to the now all important study of marine zoology." Such a station, moreover, would be extremely useful "in educating young naturalists to take vigorously in hand the anatomy, histology, and embryology of marine animals, since there is scarcely a more appropriate place in Scotland for this study. I know it well enough," he added, "having passed more than one holiday near the venerable University, and hope to do so once more this summer."

In 1882 the practical zoological laboratory in the University was used as a marine laboratory, and efforts were made to obtain part, viz. £300, of the surplus (about £1800) from the Edinburgh Fisheries Exhibition for the erection of a special marine laboratory. The whole of the surplus, however, was required for the Granton Marine Laboratory.

Efforts, nevertheless, were continued, and the experiments in St. Andrews Bay and elsewhere along the eastern shores in connection with H.M. Trawling Commission (1884—85) gave additional impetus to the movement. At last the Government, mainly at the instigation of the late Earl of Dalhousie, early in 1884, granted a sum to be devoted to this purpose through the Fishery Board for Scotland, and an immediate commencement was made by taking a lease of a wooden building between the harbour and the beach and fitting it with tanks, pipes, gas-engine, and pump, while the services of a trained fisherman were also obtained.* Even before the fittings were in order many observations in connection with the trawling work were carried out by aid of a temporary apparatus formerly used in salmon-hatching near the Tay. These operations are embodied in the Trawling Report.† Amongst the rarer forms procured for the Labora-

* A brief account of the structure of the Laboratory is given in the 'Third Annual Report of the Fishery Board for Scotland,' 1885.

† 'Report of the Commissioners, Trawl, Net, and Beam-Trawl Fishing, 1885,' Lord Dalhousie, chairman.

tory this year (1884) was a new fish to British waters, viz. *Lumpenus lampetriformis*, Walb.,* a form well known in Norwegian waters, several specimens of which, all less in size, have since been obtained by trawlers in the Moray Frith. The somewhat scarce *Cottus quadricornis* was also obtained and many rare invertebrates, *e. g.* *Corymorpha* amongst the Zoophytes; the anemones *Stomphia* and *Harmathia*; *Hippasterias* amongst Echinoderms; *Pleurophyllidia* and the egg-capsules of *Fusus norvegicus*. The advantages afforded by the Laboratory were also utilized this year (1884) by Professors Ray Lankester and Hubrecht (of Utrecht), and Mr., now Prof., A. G. Bourne. The first-mentioned worked upon a unique Gephyrean (*Golfingia McIntoshii*),† Prof. Hubrecht devoted himself to the Nemerteans, while Mr. Bourne examined the development of the Mollusca. Mr. (now Rev. R.) Gillespie, Demonstrator of Zoology at the University, also materially aided in carrying out the work in connection with the Royal Commission on Trawling. There can be no question that the latter observations were greatly facilitated by the conveniences of the Laboratory; for the boats bringing ova of the food-fishes procured at sea, and other living products of the expeditions, could approach within a few yards of the Laboratory—where further study of the living specimens could take place.

This year also the reproductive organs of the common mussel were examined from January to July, and an abstract published‡ early next year along with some observations on the British species of *Cyanea*.§

In the following year (1885) the observations on the reproduction and development of fishes received a fresh impetus from the labours of Mr. Edward E. Prince,‖ who, under Prof. McIntosh, worked at the subject till September.¶

* Vide account of the specimen by F. Day, 'Proceed. Zool. Soc.,' June 17th, 1884.

† 'Trans. Linn. Soc.,' 2nd ser., "Zool.," vol. ii, pt. 16, 1885.

‡ 'Ann. Nat. Hist.,' 3rd ser., vol. xiv, p. 149, Feb., 1885.

§ A brief note on the same appeared in the '3rd Annual Report of the Fishery Board.'

‖ Vide papers, 'Ann. Nat. Hist.,' Dec., 1885, and May, 1886.

¶ See 'Nature,' April, 1885; 'Annals of Nat. Hist.,' June, 1885, 1 plate.

The food-fishes received the first attention, such as the cod, haddock, whiting, ling, eel, flounder, dab, gurnard, herring, and others; while the lump-sucker, viviparous blenny, catfish, short-spined *Cottus*, armed bull-head, bimaculated sucker, Montagu's sucker, dragonet, rockling, glutinous hag, sand-eel, *Gastrosteus spinachia*, &c., were also examined. The pelagic ova of the majority of the food-fishes were made the subject of special investigation. The multiple tumours of plaice and the flounder also received notice. Some experiments were further made on phosphorescence and the results embodied in the President's address to the Biological Section of the British Association.* Additional observations on the development of the mussel were carried out this year by Mr. John Wilson.†

Other published observations included remarks on a new British *Staurocephalus*, peculiar processes formed by *Cerapus* on Tubularia, on certain ova, probably of a Cephalopod, according to Mr. Hoyle, from the Forth, and on the milk of the porpoise (chemically examined by Prof. Purdie).

Prof. Cleland, of Glasgow, lastly, made some anatomical researches on the tail of *Myxine*.‡

The capture of a very fine tunny towards the end of the year by a Granton trawler, enabled some observations to be made on a fresh example of this rare fish, about nine feet in length,§ and the skeleton will probably form the subject of a subsequent communication.

The researches on the development and life-histories of the food-fishes were continued by Prof. McIntosh and Mr. Ed. E. Prince in 1886, in the beginning of which year a noteworthy capture of a huge mass of the large demersal eggs of the catfish (*Anarrhichas lupus*) was made in St. Andrews Bay. The embryos were far advanced in these eggs, but a tolerably complete history of this form was drawn up by aid of these specimens, and they were kept in

* 'Report, Brit. Assoc.,' 1885.

† Vide 'Report, Brit. Assoc.,' 1885, and 'Report, Fishery Board for Scotland,' 1886.

‡ 'Report Brit. Assoc.,' 1885.

§ 'Ann. Nat. Hist.,' April, 1886, and June, 1886.

the Laboratory till the commencement of the post-larval stage. The pelagic eggs of the ling were procured in considerable numbers at sea by aid of a liner, who fertilized the ova, and transmitted them to the Laboratory. Further remarks were also made on the tunny, on the affinities of the poor or power cod, and the bib, on the weevers, on the parental instincts of *Cyclopterus*, on the very young cod and other food-fishes, on the capture of food-fishes by the liners, on the injuries to baited hooks and to fishes on the lines, on shrimp-trawling and sprat-fishing, on the ova of a number of other fishes, on the effect of storms on the marine Fauna, and on certain invertebrates, including forms used as bait.* Remarks on an abnormal Hydromedusa (Thaumantias) devoid of mouth were also communicated to the British Association. Some experiments on the preservation of mussels for bait were likewise carried out at the Laboratory, proving that by the aid of a solution of such a substance as boro-glyceride they can be kept for a period of several weeks in winter (after they have been put on the lines) and for a shorter period in summer. Moreover, it was found that the use of such a preservative does not seem to impair the usefulness of the bait on the fishing grounds.

This year Mr. Wilson further extended his observations on the development of the mussel (*Mytilus edulis*), while Dr. Scharff, now of the Museum of the Royal College of Science, Dublin, carried out an interesting inquiry into the ovarian ova of Teleosteans. Mr. E. E. Prince further published papers on the early stages in the development of the food-fishes, on oleaginous spheres in the yolk of Teleostean ova, and on the development of the pectoral fins in Teleosteans.

The use of a huge midwater net made at the Laboratory greatly facilitated the study of the life-histories of the food-fishes and other forms.

In 1887 the researches on the development of Teleosteans were further extended, especially in regard to post-larval stages, the use of the large mid-water net on board the Fishery steamer "Garland" and also in the Yawl "Dal-

* Vide 'Ann. Nat. Hist.,' May, June and August, 1886; 'Nature,' 1886, and 'Report to Fishery Board for Scotland,' 1886.

housie" being attended with noteworthy results. Besides aiding Prof. McIntosh with this work, Mr. E. E. Prince communicated further researches "On the Teleostean Pectoral Fin" to the British Association, "On the Development of the Ovary and Oviduct in Certain Osseous Fishes," "On the Luminous Organs of the Pearl-sides," and "On the Structure of *Tomopteris*." Other papers from the Laboratory (by Prof. McIntosh) were, "On the Pelagic Fauna of our Shores in its Relation to the Nourishment of the Young Fishes,"* "On the Occurrence of Peculiar Gelatinous Bodies in Profusion," "On *Syncoryne decipiens*," "On the Commensalistic Habits of the Larval Forms of *Peachia*," "On the Presence of Swarms of Appendicularias," and "On the Occurrence of *Clione borealis* in St. Andrews Bay.† Further remarks were given on post-larval fishes, young gunnel, *Liparis* and *Labrus*.‡ A considerable paper, with three plates, was written by Mr. E. E. Prince on his "Researches on the Development and Morphology of the Limbs of Teleosts." This will be published soon in America.§

Prof. Burdon Sanderson and Mr. Gotch, of Oxford, for some time in summer carried out a series of interesting physiological researches on the electrical organs of the skate (chiefly the thornback and grey skate), and as the fishes had to be not only living but perfectly fresh, the advantages of the Laboratory in this respect were conspicuous. Mr. H. E. Durham, B.A., of Cambridge, again, conducted various minute investigations into the life-history and functions of the perivisceral corpuscles of the star-fishes (*Asterias*, &c). Prof. D. J. Cunningham, of Trinity College, Dublin, commenced an inquiry into the vertebral column of young Teleosteans, while Prof. Purser, of the same University, studied the physiology of various invertebrates. Lastly, Dr. Gunn, of Moorfields Ophthalmic Hospital, London, began in February an inquiry at the Laboratory into the

* 'Ann. Nat. Hist.,' Feb., 1887.
† Ibid., August, 1887.
‡ Ibid., Oct., 1887.
§ Elizabeth Thompson Fund.

minute structure of the Teleostean eye, from the early embryo onwards. He is still busy with this research.

Besides the marine researches carried out since the opening of the Marine Laboratory, it is necessary to point out that many previous zoological inquiries had been made at St. Andrews. These are indicated in the 'Marine Invertebrates and Fishes of St. Andrews,' in the 'British Annelids,' Part I (Ray Society), and other publications; and that numerous specimens have been freely sent to scientific workers at home and abroad, as well as to the British Museum and other collections.

While the main purpose of the establishment is the increase in our knowledge of the food-fishes, edible invertebrates, and all that relates to them, it is self-evident that a knowledge of the intricate environment of these cannot be satisfactorily made without a series of collateral researches into various departments of marine zoology, and, therefore, the work has been carried out on a broad basis. The practicability of increasing the supply of marine fishes of value, *e. g.* the sole, in places where it is only rarely met with, has never been lost sight of; and though the Fishery Board have not yet granted the necessary aid of a steamer, it is to be hoped that this obstacle will soon be overcome. The closure of the bay, as insisted on in the 'Trawling Report,' would give most favorable opportunities for such experiments.

A large series of original coloured drawings, of great beauty (by the late Mrs. Günther), and a mass of MS. in connection with the monograph on the 'British Annelids,' for the Ray Society, are in hand. The collection of specimens (in spirit and microscopic) in connection with this work is also very extensive.

It may, in conclusion, be mentioned that the life-histories of the important food-fishes, such as the cod, haddock, whiting, ling, green-cod, gurnard, bib, poor cod, various flat fishes (*Pluronectidæ*), catfish, and others, have been more or less completely followed from the egg onward. This is more difficult than it at first sight appears, for it is only by prolonged use of such an apparatus as the large mid-water net—inshore and in deep water—that reliable data

can be obtained. The early post-larval stages of several of the important round fishes so closely resemble each other that even now there is a margin for doubt. It is only when distinctive structural features or characteristic tints make their appearance that certainty is obtainable.

The proximity of the important mussel-beds at the mouth of the Eden has afforded opportunities for investigating the development and life-history of this species, and also for carrying out experiments in mussel cultivation. These will be embodied in a report on the subject for the managers (Town Council of St. Andrew's).

The great advantages of easy access to the University Museum and University Library have been from the first conspicuous, and a source of satisfaction and benefit to the workers. It would, indeed, be difficult to over estimate the privileges of the Marine Laboratory in these respects.

List of papers published since the opening of the St. Andrews Marine Laboratory up to and including 1887.

1. Report I to the Fishery Board for Scotland, 1884.
2. Report on Trawling at the request of Lord Dalhousie, Chairman of the Trawling Commission, 1884–85.
3. Report II to the Fishery Board for Scotland, 1885. (1 Plate.)
4. Report III to the Fishery Board for Scotland up to 31st December, 1885.
5. Report IV to the Fishery Board for Scotland (year 1886), 1887.

The foregoing by Prof. McIntosh.

6. On the Occurrence of *Lumpenus lampetriformis* off the East Coast of Scotland, by Francis Day. Proceed. Zool. Soc., 1884, p. 445. (1 Plate.)
7. Notes from the St. Andrews Marine Laboratory, I. A. On the British species of *Cyanea*. B. On the Reproduction of *Mytilus edulis*.—Prof. McIntosh, Ann. Nat. Hist., Feb., 1885.
8. Notes from the same, II. On the Spawning of certain Marine Fishes (Herring, viviparous Blenny, Catfish, short-spined Cottus, armed Bullhead, bimaculated Sucker, and Montagu's Sucker); On Pelagic Ova, the Young of the Ling and the Eel. (1 Plate.) —Ibid., Ann. Nat. Hist., June, 1885.
9. Lecture on the Ova of Fishes.—Ibid., Nature, April, 1885.
10. The Phosphorescence of Marine Animals, the Presidential Address to the Biological Section of the British Association, Sept. 1885. —Ibid.
11. Notes from the St. Andrew's Laboratory, III. A. On the Ova of *Callionymus lyra*. B. On a new British *Staurocephalus*. C. On certain Processes formed by Cerapus on *Tubularia indivisa*. D. On certain Peculiar Ova from the Forth. E. On a Female Porpoise. (1 Plate.)—Prof. McIntosh.

12. Note on the Chemical Composition of the Milk of the Porpoise.—Prof. Purdie, Ann. Nat. Hist., December, 1885, and Chemical News.
13. On the Development of the Food-Fishes at the St. Andrews Marine Laboratory.—E. E. Prince, Rep. Brit. Assoc., 1885, p. 1091.
14. On the Nest and Development of *Gastrosteus spinachia* at the St. Andrews Marine Laboratory.—E. E. Prince, Report Brit. Assoc., 1885, p. 1093, printed in full with 1 Plate, Ann. Nat. Hist., Dec., 1885.

14*a* and 15. On the Reproduction of the Common Mussel.—John Wilson, Report, Brit. Assoc., 1885, p. 1094, and Report Fishery Board for Scotland, 1886.

16. On *Golfingia McIntoshii*, a new Sipunculus from the Neighbourhood of St. Andrews.—Prof. Ray Lankester, M.A., LL.D., F.R.S., &c., Trans. Lin. Soc., vol. ii, pt. 16. (2 Plates.)
17. Notes from the St. Andrews Laboratory, IV. On the Structure of the Tunny. (1 Plate.)—Prof. McIntosh, Ann. Nat. Hist., April, 1886.
18. On the British Weevers, the Bib, and the Poor Cod.—Ibid., Ann. Nat. Hist., May. 1886.
19. Early Stages in the Development of the Food-Fishes.—E. E. Prince, Ann. Nat. Hist., May 1886.
20. Further Remarks on the Tunny.—Prof. McIntosh, Ann. Nat. Hist., June, 1886.
21. Remarks on the Eggs of Marine Fishes.—Ibid., Nature, 1886.
22. On the Presence of Oleaginous Spheres in the Yolk of Teleostean Ova.—E. E. Prince, Ann. Nat. Hist., Aug., 1886.
23. Points in the Development of the Pectoral Fin and Girdle in Teleosteans.—E. E. Prince, Report, Brit. Assoc., 1866, p. 697.
24. Some Remarks on the Egg-Membranes of Osseous Fishes.—Dr. R. Scharff, Ibid., p. 698.
25. Note on a Peculiar Medusa (*Thaumantias*) from St. Andrews Bay.—Prof. McIntosh, Ibid., p. 710.
26. On the Structure of the Tail in *Myxine*.—Prof. Cleland, M.D., LL.D., F.R.S., Report Fishery Board, 1886, p. 211.
27. Report of the Committee for the Purpose of Continuing the Researches on Food-Fishes and Invertebrates at the St. Andrews Marine Laboratory.—Report Brit. Assoc., 1886.
28. Notes from the St. Andrews Marine Laboratory, V. On the Paternal Instincts of *Cyclopterus lumpus*, &c.—Prof. McIntosh, Ann. Nat. Hist., August, 1886.
29. Notes from the St. Andrew's Marine Laboratory, VI. On the very Young Cod and other Food-Fishes.—Prof. McIntosh, Ann. Nat. Hist., Oct., 1886.
30. On some Experiments in Preserving Mussels for Bait.—Report Fishery Board for 1886 (published 1887).
31. On the Intra-Ovarian Eggs of Osseous Fishes.—Dr. R. Scharff, Proceed. Roy. Soc., 1887, and Quart. Journ. Micros. Sci., Aug. 1887. (1 Plate. 4to.)
32. On the Pelagic Fauna of our Shores in its Relation to the Nourishment of the young Food-Fishes.—Prof. McIntosh, Ann. Nat. Hist., Feb. 1887.
33. Notes from the St. Andrews Marine Laboratory, VII. A. On the Occurrence of Peculiar Gelatinous Bodies in Profusion. B. On *Syncoryne decipiens*, Dujardin. C. On the Commensalistic Habits

of the Larval Forms of *Peachia*. D. On the Presence of Swarms of Appendicularias. E. On the Occurrence of *Clione borealis*, Pall.—Ibid., Ann. Nat. Hist., Aug., 1887.

34. Notes from the St. Andrews Marine Laboratory, VIII. A. On a Post-larval *Labrus*, with Remarks on the Colour of Pelvic Fins. B. On the Post-larval Condition of *Liparis*. C. On a Peculiar Teleostean Yolk-sac. D. General Remarks on Post-larval Food-Fishes.—Ibid., Ann. Nat. Hist., Oct., 1887.
35. On some Rare and Remarkable Forms at St. Andrews Marine Laboratory.—Prof. McIntosh, Meeting Brit. Assoc., 1887.
36. On the Development of the Ovary and Oviduct in Certain Osseous Fishes.—E. E. Prince, Ibid., 1887.
37. On the so-called Luminous Organs of *Maurolicus Pennantii*.—E. E. Prince, Report Brit. Assoc., 1887, p. 769.
38. On the Ova of *Tomopteris onisciformis*, Esch.—E. E. Prince, Report Brit. Assoc., 1887, p. 769.
39. On the Ciliated Organs of Tomopteris.—E. E. Prince, Ibid., p. 769.
40. The Emigration of Amœboid Corpuscles in the Star-fish.—Herbert E. Durham, B.A., lately Vintnor Exhibitioner, King's College, Cambridge, Proceed. Roy. Soc., vol. 43, p. 327. (1 Plate.)
41. Note on the Madreporite of *Cribrella oculata*.—Ibid., Proceed. Roy. Soc., vol. 43, p. 330.
42. On the Reproduction and Development of the Common Mussel. (three 4to Plates).—John Wilson, B.Sc., Demonstrator of Zoology, St. Andrews University, V, Report, Fishery Board for Scotland, p. 247, 1887.
43. The Significance of the Yolk in the Eggs of Osseous Fishes.—E. E. Prince.—Ann. Nat. Hist., July, 1887. (1 Plate.)

Not yet Published.

44. On the Development of the Food-Fishes and Others, with 31 Plates, 4to.—Prof. McIntosh and E. E. Prince, St. Andrews Marine Laboratory. Ready for communication to the R. S. E.
45. On the Electrical Organs of the Skate.—Prof. Burdon Sanderson and F. Gotch, Esq, M.B., &c., Proc. R. S., 1888.
46. On the Minute Structure of the Teleostean Eye from its Early Embryonic Condition Onward.—Dr. Marcus Gunn, M.R.C.S., &c. *Vide*, for abstract ensuing Report, Fishery Board for Scotland.

A Summary of the Work done by the Liverpool Marine Biology Committee during 1885-87.

By Professor W. A. Herdman, D.Sc., F.L.S.

The Liverpool Marine Biology Committee was formed in March, 1885, for the purpose of investigating thoroughly the Fauna and Flora of Liverpool Bay and the neighbouring parts of the Irish Sea. The aim of the Committee is not merely to draw up an accurate list of the species found in this locality, but also to observe and record the relative numbers, the size, the colours, and the condition generally of the specimens, the exact localities in which they are found, the other species of animals and plants associated with them, and their mutual relations as food, enemies, or competitors. In this way it is hoped that a mass of observations will be accumulated which may be of use in determining the geographical distribution of various forms, the nature of the conditions which influence species, and the relations existing between the different plants and animals. It was felt at the outset that this work was exactly that department of biological investigation which could be best carried out by an organised body of workers who would subdivide the area to be investigated, and the groups of animals and plants to be worked up between them, and would carry on systematic observations year after year, sending in periodic reports upon their work. The value, in fact the absolute necessity, of this organisation, division of labour, and systematic arrangement, for the successful accomplishment of the objects in view, has been felt all along by the members of the Committee and those naturalists who have worked with them; and the results attained so far have, I think, fully justified their belief in the benefit to be derived from scientific organisation.

The operations of the Committee have been carried on

now for three seasons, and the practical part of the work has consisted of dredging expeditions, lasting in some cases for several days at a time, tow-netting expeditions in small boats, and shore expeditions for the investigation of the littoral Fauna. A considerable extent of the large quadrangular area* of the Irish Sea extending around Liverpool Bay, and bounded by the Isle of Man and the coasts of Anglesey, North Wales, Cheshire, and Lancashire has now been explored, large collections have been made, and a first volume of reports† has been published consisting of twenty-nine articles written by twenty-one biologists and illustrated by ten plates and two maps of the district. These reports record the occurrence of 913 species,‡ of which at least 235 had not been found previously in this neighbourhood. Sixteen of these species have not been previously discovered in British seas, and at least seven species and three varieties are new to science, so that a considerable measure of success has already attended the efforts of the Committee. It is evident, however, that such work must be a matter of time, and that every additional year's records will add to the value of any conclusions that may be drawn in regard to the Fauna under consideration.

The records already made have attracted attention to several general questions which are now being investigated.

One of these is the detection of changes in the local Fauna which have taken place, or may take place in the future. Some of the rarer Nudibranchs, such as *Embletonia pallida* and *Antiopa hyalina*, formerly found on the shores of Hilbre Island at the mouth of the Dee, have probably disappeared entirely from that locality. On the other hand, the rare Hydroid *Garveia nutans* seems to have migrated lately into Liverpool Bay, and to be spreading there with rapidity. It was first noticed in this neighbourhood on May 9th, 1885, while dredging in Hilbre Swash, and since then has been found at Hilbre Island, Colwyn Bay, off Puffin Island, and

* Generally called for short in the Reports, the L. M. B. C. district.

† 'First Report upon the Fauna of Liverpool Bay,' &c., Longmans, London, 1886.

‡ Since increased to over a thousand species.

in various other parts of the district. The Hydroid Fauna had been so carefully investigated for many years previous to 1885 by excellent observers that this conspicuous species could scarcely have escaped observation if it had been present in the neighbourhood. It is interesting to find that Professor Haddon has recorded *Garveia nutans* as having made its appearance in Dublin Bay for the first time also in 1885.

The distribution of the various species of the littoral Fauna, according to the distance above low-water mark, is of importance on account of the influence which the position on the shore must have upon the habits and mode of life of the animals. The Polyzoon *Flustrella hispida* has been found at Hilbre Island, living and healthy, about one yard below high-water mark, in such a position that it could only have an opportunity of being covered by the sea and of taking in food during two short periods in each twenty-four hours, and must be exposed to the air during about five-sixths of its existence.

During the second season (1886) it became obvious to the Committee that in order to advance further in their work, so as to be able to make more minute explorations, and to carry on detailed investigations into the habits and life-histories of the animals, it would be necessary to establish a small observing station or marine laboratory at some suitable spot in the district. After some preliminary inquiries they decided upon Puffin Island, off the north entrance to the Menai Straits, and were fortunately able to obtain from Sir Richard Bulkeley the use of the old Dock Board Signalling Station, which stands upon the seaward or north-east point of the island. This building has now been converted into a simple but efficient Biological Station* capable of accommodating about half-a-dozen workers at a time. The shores of Puffin Island are rocky and support an abundant Fauna, and good dredging ground is present in the immediate vicinity. The Puffin Island Station was established early in the summer of 1887, and has been open continuously since

* For a description, with figures, see 'Nature,' July 21st, 1887.

then*. It has already shown itself to be of great value to the Committee by enabling them to live for a few days or weeks at a time in the centre of the richest Fauna of the district, and by giving them facilities for undertaking work which could not otherwise have been done. Moreover, the keeper of the station is constantly employed in collecting animals, and in dredging when possible; and he has been able to provide the Committee with a continuous series of surface tow-nettings extending throughout the autumn and winter, and taken in some cases during the night. These are being worked up by Mr. I. C. Thompson, F.L.S., and have already yielded several points of interest; for example, the parasitic Copepod *Trebius caudatus* has only been taken in the tow-net during the night, and appears to be then free-swimming. Another interesting parasitic Copepod, *Lichomolgus sabellæ*, new species, was first found last summer near Puffin Island attached to the branchial plumes of the Annelid *Sabella penicillus*.

Some parts of the L. M. B. C. district are particularly good localities for Nudibranchiate Mollusca. Forty-two species were recorded in the report published in 1886, and since then members of the Committee have found several additional species, including *Fiona nobilis*. The rocks at Hilbre Island and Puffin Island are especially good collecting ground, but the assemblage of Nudibranchs on the shore is very different at different times of the year. There is no doubt, from the observations of the Committee, that the Nudibranchs migrate in large numbers at certain times into the littoral zone, and then after a time disappear again into the deep water. They seem to come on shore primarily for spawning purposes, but may be influenced by other circumstances also.

In the other groups the chief results obtained are as follows:

In the Protozoa, the Foraminifera alone have been fully worked up. One hundred and sixty-two species have been found, including three new to science, viz. *Placopsilina*

* For a summary of the work done at the station during the first year, see 'Proc. Liverpool Biol. Soc.,' vol. ii, p. 38, 1888.

Kingsleyi (Siddall), *Reophax moniliforme* (Siddall), and *Miliolina spiculifera* (Siddall). Forty species of Sponges are recorded, including two new forms, *Aphroceras ramosa* (Carter), and *Sycandra aspera* (Gibson). A very large number of Hydromedusæ have been found and examined. The most important form is *Garveia nutans* (Wright), referred to above. Amongst the Actinozoa is a new variety of *Cylista undata* (Müller), and *Sarcodictyon catenata* (Forbes), which has been found living and kept under observation for some time. The Echinodermata and the Vermes, although numerous, have as yet yielded nothing remarkable. Over a hundred species of Polyzoa have now been recorded by the Committee, including at least one new species, *Ascopodaria nodosa* (Lomas), allied to *Pedicellina*. The Copepoda, as a result of the regular tow-nettings taken round Puffin Island by the keeper of the Biological Station, and sent to Mr. Thompson for examination, have been very numerous, and have included a large number of rare and interesting forms of which some are new to British seas, and the following have been described as new species :

Cyclops puffini (Thompson), *Lichomolgus sabellæ* (Thomps.), *Cymbasoma herdmani* (Thomps.), and several others still unpublished. Amongst the higher Crustacea Mr. A. O. Walker, F.L.S., has recorded some rare northern forms of Amphipoda, four species of Schizopoda, two of Cumacea, and a large number of Decapoda. The Pycnogonida collected contain several rare forms, and one, still undescribed, which is probably new to science. The Nudibranchiata have been already referred to above; the lists of other Mollusca present nothing of special importance. The report upon the Tunicata deals with forty-seven species of which at least two (*Morchellioides alderi*, Herdman, and *Polycarpa monensis*, Herdm.) are new to science, while seven have not been previously recorded from British seas. Nineteen of the species are simple Ascidians, twenty-seven are compound, and the remaining one is the pelagic *Oikopleura flabellum*.

Several preliminary lists of the Algæ of the district have been drawn up, and the whole group is now in the hands of Mr. R. J. Harvey Gibson, Lecturer on Botany in University

College, Liverpool, who is at present systematically examining the seaweeds growing on the shores of Puffin Island. The Fishes have not yet been systematically worked up, and the Committee have not undertaken any economic investigations, their object being in the first place to make a complete examination of the L. M. B. C. district for purely scientific purposes.

In conclusion, I would emphasise my opinion that such biological work as the investigation of the Fauna and Flora and the physical conditions of a district can be carried out best by a small body of naturalists, such as the Liverpool Marine Biology Committee, subdividing the work, devoting themselves to their special groups, but working together as much as possible so as to keep thoroughly in touch with their fellow-workers, and to understand the scientific bearing of their results and observations. Such bodies of naturalists should be easily organised in all populous maritime districts where there are teachers of Biology and Scientific Natural History Societies. There is abundance of work for them to do on almost every part of our coast line. Liverpool Bay has not a specially rich Fauna. In fact it is distinctly poorer than some other districts, such as the estuary of the Clyde, and yet the Committee here feel that they have little more than commenced their work. A laboratory, however small, placed close to the scene of operations, is a most important addition in marine investigations; and it is not too much to hope that each of our Universities, Colleges, and more important scientific societies situated within reach of the sea will in course of time establish its own Marine Station as a necessary adjunct to its Biological Department.

The Scottish Marine Station and its Work.

By William E. Hoyle, M.A.

The "Scottish Marine Station for Scientific Research" has now been at work for a little over four years, so that the present seems a fair opportunity to inquire what has been accomplished by its means. The object of the present article is to supply this information, and to show to what extent the results obtained have justified the expectations of its promoters.

It may be well at the outset to lay before the reader in a few words the circumstances which led to the establishment of this institution, as well as the means which have been at its disposal. The nucleus of its pecuniary resources was a sum of £1400, the surplus from the Edinburgh Fisheries Exhibition of 1882, which was handed over to the Scottish Meteorological Society for the purpose of carrying on investigations which they had already commenced into the herring and other fisheries, "with power to establish a zoological station and also to endeavour to get Government to assist them in the work." The application to Government for assistance was unsuccessful. Dr. John Murray, of the "Challenger" expedition, however, offered to found a zoological station, and to maintain it for at least three years, provided the Council of the Society would give him an annual grant from the fund of £250 for these years. This offer was accepted, and on April 14th, 1884, the Institution was inaugurated, and systematic work commenced. At the outset Dr. Murray received assistance from friends and others interested in the work, and has also received grants from the British Association, and the Government Grant Committee.

The station had its head-quarters in the old quarry at Granton, about two miles and a half distant from Leith,

which had been flooded in 1855 owing to its outer wall giving way. It has an area of seven acres, and there is a narrow opening leading to the sea, through which a vessel drawing six feet of water can be navigated at about high water. The late Duke of Buccleuch granted Dr. John Murray a fifteen years lease of the quarry at the almost nominal rent of 15*s.* per annum.

Fig 1.—Plan of Granton Quarry, the original site of the Scottish Marine Station. From a survey by Mr. H. J. Gifford. The figures represent the depth in feet.

Two large vessels, the "Ark" and the "Medusa," with several rowing boats, made up the outfit, and still constitute a most important part of the Station's appliances. The former is a floating laboratory, and was moored in the

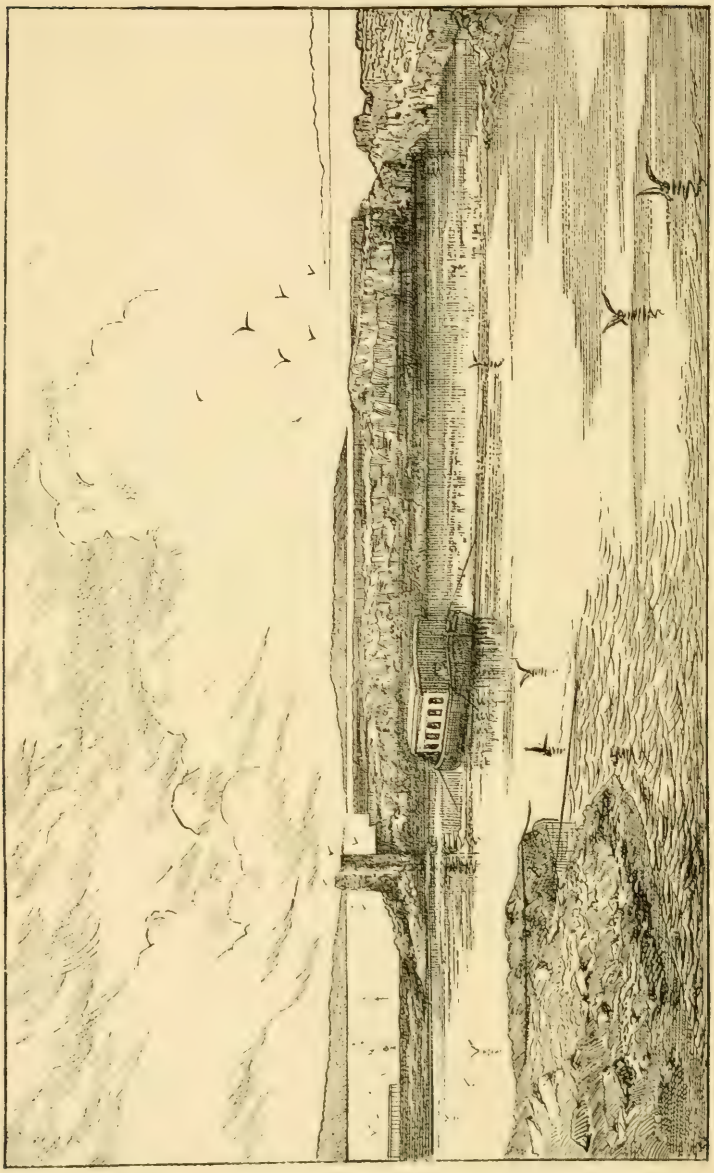


FIG. 2.—View of the Quarry with the "Ark" afloat, looking west. From a photograph by Mr. H. J. Gifford.

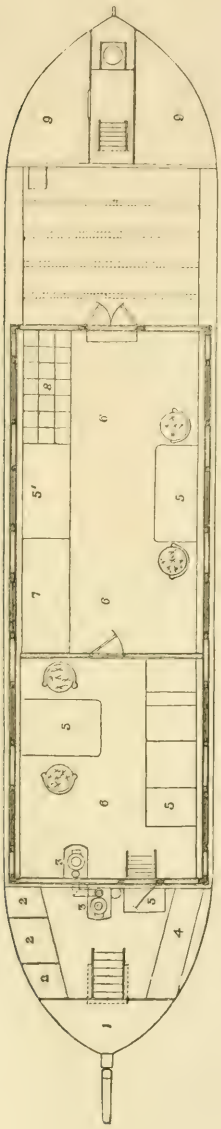


FIG. 3.—Plan of the "Ark," showing the internal arrangements. 1, Coal bunker; 2, lockers; 3, stoves; 4, keeper's berth; 5, wooden tables; 5', 7, 8, tables for aquaria; 6, lockers under flooring; 9, fore-cabin.

centre of the quarry. She consists of an iron hull, sixty-four feet long by thirteen feet broad, formerly used as a lighter; about the centre of her length a raised cabin was built, leaving a free space at either end, and thus imparting to the whole a striking resemblance to the craft of the toy-shops after which she is named. The cabin is divided into two compartments, one of which is furnished with arrangements for physical work, and with appliances for keeping specimens alive in vessels through which a constant stream is passed, a wind-pump on the roof raising the water for this purpose. The other room contained tables for microscopic work, shelves for reagents, and the usual paraphernalia of a biological laboratory. The quarry itself was made to serve as a kind of natural aquarium by enclosing specimens of various kinds in submerged cages, which were attached either to the "Ark" itself or to suitable floats in various places.

The "Medusa," the steam yacht used for sounding and dredging, is fifty-one feet in length, twelve feet in beam, and a little over thirty tons burthen, yacht measurement. There is a single mast in the fore part of the vessel, and from it there projects forwards a derrick with blocks through which pass the sounding or dredging lines. Each of these has its own special drum, placed on an axle abaft the mast, and actuated by a small steam engine. In the after part of the vessel is a cabin, capable of holding several persons, in which it is possible to examine the captured material with the microscope.

The sounding line is of hemp, this being regarded as safer where instruments are attached, while the depths are so small that but little saving in time would be effected by the use of wire. The dredging rope is of phosphor bronze, nearly half an inch in diameter, and 200 fathoms of it are coiled round the drum.

Since the station was inaugurated several changes in its arrangements have taken place. A spacious laboratory with aquaria in the basement has been erected on shore at Granton within a large enclosure, and the "Ark" has been removed to Millport in the Firth of Clyde, where it serves as a kind

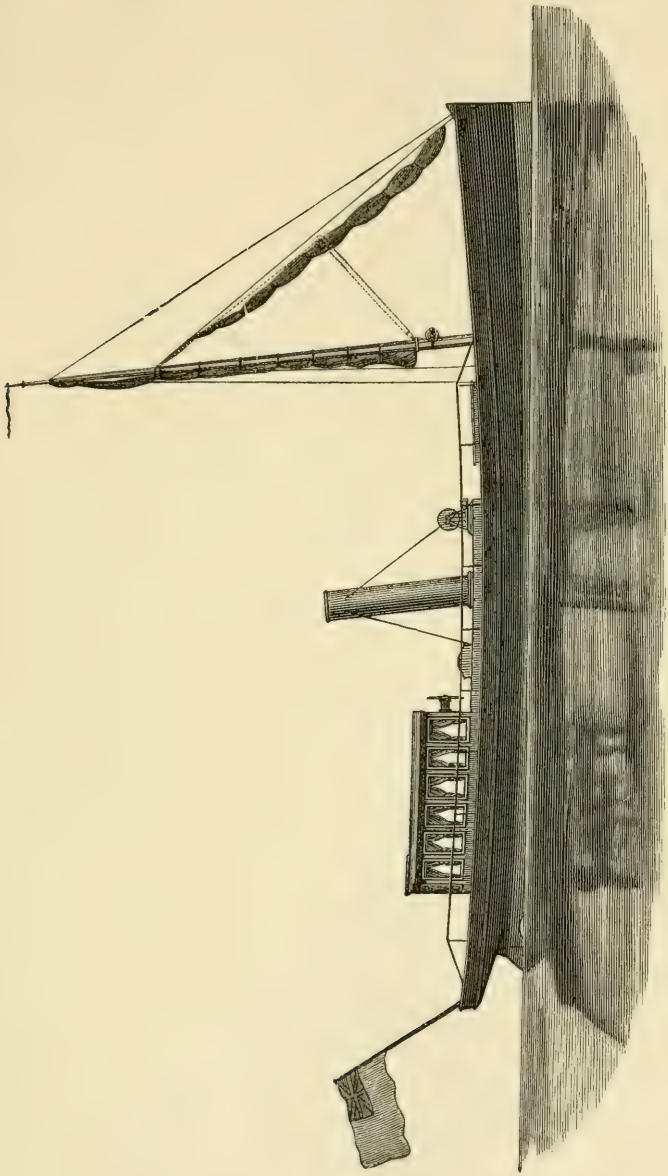


FIG. 4.—The "Medusa." Scale, one inch to the foot.

of head-quarters for work on the west coast. The "Medusa" has for some time back been employed almost exclusively on the west coast; her build is rather light for the heavy swells often experienced in the Firth of Forth, and her place on the east coast has been supplied by the hiring of tugs, and by expeditions in steam-trawlers and herring-boats as occasion requires.

The institution has from the commencement been under the direction of Dr. John Murray, and at the present moment the staff consists of the following members:—The scientific work of the laboratory at Granton is mainly under the direction of Mr. J. Arthur Thomson, M.A., the general charge of the premises being undertaken by the custodian Mr. W. Bell, who resides on them. On the west coast Mr. David Robertson, F.L.S., whose researches in Scottish zoology are so well known, has been good enough to exercise supervision over the "Ark" since its removal to Millport; the "Medusa" has been under the care of Mr. Alexander Turbyne, to whose practical skill and energy much of the success of the work in this district is due. He is assisted by an engineer, Mr. W. Harrison, and a seaman.

Having thus obtained an idea of the resources which were at the command of this enterprise, let us pass in review as completely as is practicable within the limits of a single article, the results which have been accomplished by its means. These will be discussed under two heads, physical and biological, and we shall commence with the former.

Physical Investigations.

When the actual work of the station commenced, its first and most obvious duty was to explore its own domains, and thus Dr. Hugh Robert Mill, who presided over this department, was led to an investigation of the periodic variations of temperature and other phenomena in the Granton quarry, in which the "Ark" was afloat. As before stated, this has an area of about seven acres, and the tidal entrance on the west side is so situated that no water can enter till about half tide; it then runs in very rapidly for some three

quarters of an hour, when the speed diminishes, and near high water it is the same as that of the rising tide along the shore. The ebb is gradual at first, but when the entrance has been narrowed by the exposure of its banks, it is accelerated for about an hour and a half. Then it runs out very slowly, its exit continuing until the flow recommences. For some five hours, however, the level of the water inside is practically unchanged. The depth of water in the quarry is from five to eight fathoms at low water. Temperatures were taken of the air and of the water, both at the surface and the bottom, at as short intervals as circumstances allowed, in some cases every half hour for thirty-six hours consecutively. The results of these observations are thus summarised by Dr. Mill :

"(1) During daylight the air was always at a higher temperature than the water, but after sunset the water was warmer than the air ; and taking an average for the whole period, the mean temperature of the air was the higher.

"(2) The surface temperature followed that of the air, and was little affected by tidal changes.

"(3) The bottom temperature followed that of the air, but the crest of the heat wave was retarded by several hours, and the curve was profoundly modified by the tides.

"(4) The temperature was higher at the surface than at the bottom during the day ; but, as a rule, it was higher at the bottom than at the surface by night.

"(5) When the tide flowed in the early morning it exercised a cooling effect on the bottom thermometers, but when it flowed at other times it produced a warming effect."

This preliminary piece of work naturally led to an inquiry into the physical conditions of the Firth of Forth, with reference, in the first place, to the temperature and salinity of the water at various times and states of the tide. For the former purpose Negretti and Zambra's deep-sea thermometer, which registers by inverting, has been used. It is shown in Fig. 5. The neck of the bulb has a contraction at A, beyond which is a reservoir, B, whilst a small receptacle, C, is provided at the other end of the tube. When the instrument is placed bulb downwards the mercury contracts

and expands in the ordinary way, but as it merely enters the reservoir, B, no reading is possible; when, however, it is inverted the mercury breaks off at A, flows down the tube,

Fig. 5.

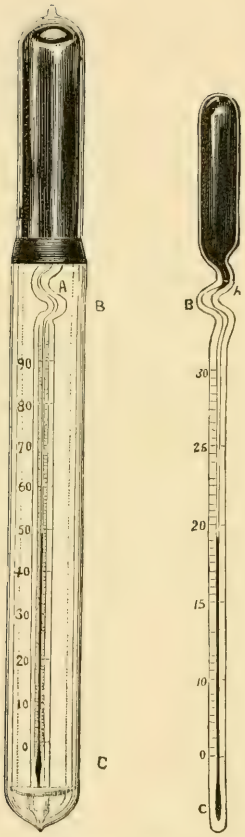


Fig. 5.—Negretti and Zambra's improved Standard Deep-sea Thermometer; and removed from within its protecting tube. A, Constriction above the bulb; B, reservoir; C, dilatation at the end of the stem. (From the "Challenger" Narrative.)

Fig. 6.

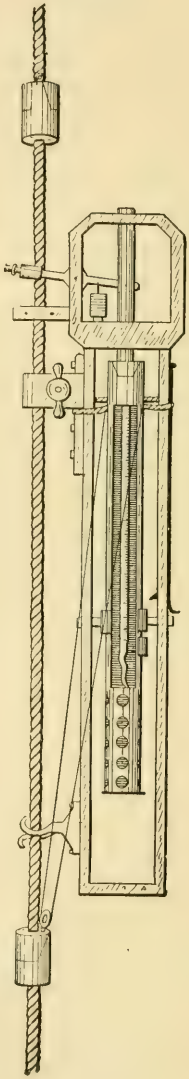


Fig. 6.—The Scottish Deep-sea Thermometer Frame. (From the 'Encyclopædia Britannica.')

filling c and a portion of the tube above. The scale reads upwards from c. Thus, whenever the existing temperature is required it is merely needful to invert the instrument and the reading can be taken at any time afterwards. The left-hand figure shows the thermometer enclosed in a stout glass tube to protect it from the pressure of the water at great depths.

The thermometer is mounted in the "Scottish" deep-sea frame shown in Fig. 6. It is swung upon pivots, and the end, c, is loaded so that it will fall down when allowed to do so by the withdrawal of a pin, which fits into a slot at that end. The outer frame carrying this revolving piece is attached to the sounding line by a double hook below and a screw clamp above. The pin, which fits into the slot, is worked by a lever, the other end of which embraces the rope, so that when it is depressed by a "messenger" (a weight which slides down the line) the pin is lifted out of the slot, and the thermometer at once turns over. When this has taken place it is held in position by a spring catch fitting into a notch. Lest the thermometer should happen to be so accurately balanced as not to turn over, an india-rubber ring is fixed to the upper part of the frame so as to give it the required initial impetus.

The messenger is the invention of Captain Rung, of the Danish Meteorological Institute, and is made in two pieces in such a way that it can be put on the line at any point. When several thermometers are placed on the line at the same time each (except the lowest) has a messenger suspended to it, as indicated in the diagram, to cause the inversion of the succeeding thermometer.

Within the last few months Professor Chrystal has constructed an instrument in which the inversion is accomplished by electricity, thus doing away with any uncertainty which may attend the action of the messengers and rendering the process instantaneous. The sounding line contains two copper wires which are connected with the terminals of a horse-shoe electro-magnet in the upper part of the frame. As soon as the circuit is completed the pin is drawn out of the slot and the thermometer turns over. The apparatus

was tried a few weeks ago in the Firth of Clyde and found to work admirably.

The salinity is a measure of the extent to which the fresh water brought down by the rivers has undergone admixture with the sea-water. It is determined by means of a delicate hydrometer, in the manner adopted by Mr. J. Y. Buchanan on the "Challenger" expedition.* When it is desired merely to study the surface water the collection of samples is, of course, extremely simple, but when it is necessary to observe the salinity of the water at various depths recourse is had to a special water-bottle which has been devised by Dr. Mill for the work.

This instrument is shown open in section in the accompanying figure. The sounding line is threaded through the central axis, A A, a strong tube which supports the whole apparatus, its lower end resting on a knob or a short cross-bar. The sides of the vessel are constituted by the cylinder, I I, F F, the bottom by the base-plate, B; this carries a ring of very soft rubber, C, forming a water-tight joint with the lower edge of the cylinder, F F. Above, complete closure is ensured by the flange, I I, pressing down upon the india-rubber saucer, H H. The weight of the cylinder, of course, drives it well home upon these pads, and so soon as this is the case it is held down by the spring catches, O O. Whilst the bottle is being lowered the cylinder is held up in the position shown by the hooks, L L, which spring outwards. A short tube, M, fits over these, and when this is driven downwards by a messenger detached from the lowest thermometer it compresses these springs and withdraws them from the flanged gallery, K, so that the cylinder is free to fall upon the base-plate and enclose the water-sample. The water is drawn off by the cock, D, air being admitted by E.

In the Firth of Forth twelve stations were fixed upon at approximately equal intervals between Alloa and the Isle of May, and serial temperatures were taken at these positions at frequent intervals. The general result of these observations is that in the landward part of the Firth the range of temperature is greater and the period of the annual maximum

* 'Narr. Chall. Exp.,' vol. i, p. 108, 1885.

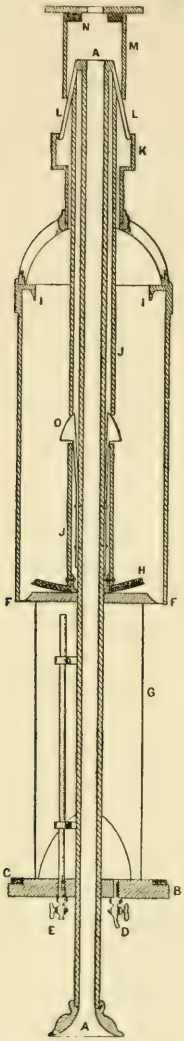


FIG. 7.—Dr. H. R. Mills' Water-bottle. A A, central tube; B, base-plate; C, india-rubber ring, to form a water-tight joint with the lower edge, F F, when the bottle is shut; D, stop-cock for emptying the bottle; E, stop-cock for admitting air; F F, edge of cylinder; G, thin plates of metal (three in number) forming guides to the cylinder; H, india-rubber saucer in which I rests when the bottle is closed; I I, knife-edged flange; J J, tube to protect lock; K, flanged gallery on top of cylinder; L L, springs sustaining cylinder; M, tube for withdrawing L L from K; N, india-rubber buffer; O, spring catches for locking cylinder when closed.

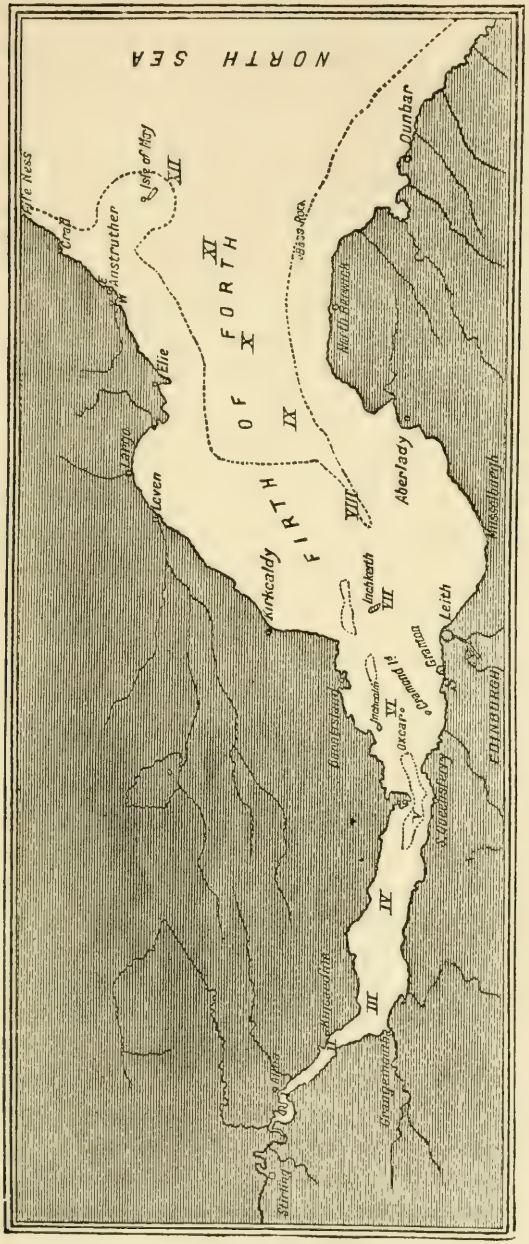
earlier than farther seaward, and, conversely, that as the sea is approached the range becomes less and the date of the maximum is retarded. At Alloa the annual range would appear to be about 35° F., at Queensferry about 20°, while at the Isle of May it probably does not greatly exceed 10°. The extreme temperatures observed in this last locality were 55° in August and 43° in December. These results and certain others are very ingeniously exhibited by Dr. Mill in a diagram constructed by means of polar co-ordinates.*

As regards the admixture of sea-water, it is found that the density increases at first very rapidly, and then more gradually as the sea is approached. The mean density at Alloa for the period during which observations were carried on was 1·00042, whilst at the Isle of May it was 1·02511. When the tide rises in the upper part of the estuary the salt water comes up underneath the fresh, damming it back and gradually mixing with it. The influence of the smaller rivers is not perceptible in the centre of the Firth ; each freshens a tract along the shore apparently not more than a mile wide.

An interesting phenomenon observed was a slight fall in the density of the water just at the mouth of the Firth, which was subsequently shown to be due to the fresher water of the Tay carried southward by the flood tide.

From the Firth of Forth it was only natural to pass to the Firth of Clyde, and the examination of this region presented a variety of questions of great interest owing to the uneven condition of its bed, whilst the investigation is facilitated by its accessibility at all times of the year. A broad submarine plateau stretches across the mouth of the Firth between the Mull of Cantyre and the Ayrshire Coast, and this, in conjunction with the fact that the opening is to the southward into the Irish Sea, diminishes the effect of the ocean water of the Atlantic. A deeper channel runs up on either side of the Island of Arran, that on the east extending directly up into Loch Fyne, where in the neighbourhood of Tarbert it attains a maximum depth of over one hundred fathoms. Between Cumbrae and Bute there is a branch of this depression, whilst a third commences north of the

* 'Proc. Roy. Soc. Edin.,' xiii, pl. vi, fig. 2.


NORTH SEA
Fife Ness
Isle of May
XII
Anstruther
Elie
FIRTH OF FORTH
XI
X
IX
Bass Rock
Dunbar
North Berwick
Aberlady
Musselburgh
Leith
Edinburgh
Inchkeith
VIII
VII
Kirkcaldy
Dysart
Burntisland
Aberdour
Dalgety
Queensferry
Cramond
Granton
Portobello
Newhaven
Cockenzie
Prestonpans
Longniddry
Gullane
Aberlady Bay
Dirleton
North Berwick Law
Tantallon
Seafield
Kinghorn
Pettycur
Kinghorn Ness
Inchcolm
Inchmickery
Oxcars
Fidra
Craigleith
Lamb
Craigentinny
Joppa
Portobello
Musselburgh
Prestonpans
Cockenzie
Longniddry
Gullane
Aberlady Bay
Dirleton
North Berwick Law
Tantallon
Seafield
Kinghorn
Pettycur
Kinghorn Ness
Inchcolm
Inchmickery
Oxcars
Fidra
Craigleith
Lamb
Craigentinny
Joppa
Stirling
Alloa
Grangemouth
Bo'ness
Carriden
Blackness
Abercorn
Hopetoun House
Dalmeny
Cramond
Granton
Newhaven
Leith
Edinburgh
Musselburgh
Aberlady
Dunbar
North Berwick
Bass Rock
Fife Ness
Isle of May
Anstruther
Elie
Largo
Leven
Kirkcaldy
Dysart
Burntisland
Aberdour
Dalgety
Queensferry
Inchkeith
Inchcolm
Inchmickery
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Musselburgh
Prestonpans
Cockenzie
Longniddry
Gullane
Aberlady Bay
Dirleton
North Berwick Law
Tantallon
Seafield
Kinghorn
Pettycur
Kinghorn Ness

Cumbraes, and extends past Dunoon up into Loch Long. Several of the lochs enclose deep basins in their upper portions, as, for instance, Loch Fyne, Loch Striven, Loch Goil, and Upper Loch Long. Such being the configuration of this area, we may next inquire how the temperature of the water varies in these different portions.

This has been summed up by Dr. Mill as follows:—(1) The *Irish Channel* has "a uniform temperature from surface to bottom, changing regularly with the season, but higher all the year round than the mean of the enclosed regions; (2) The *deep open basins* in free tidal communication with the ocean resemble the channel at all depths beneath thirty fathoms; (3) The *deep enclosed basins*, almost cut off from the tide and shut in by steep mountain walls, show the greatest range of annual temperature, and the most complicated vertical distribution. The surface water is quite fresh after heavy rains and freezes in winter. The annual range may be 35° or 40° F., while at the bottom (seventy fathoms) 5° is the greatest range observed, and the maximum temperature there occurs in early spring, when the surface water is at its minimum; the minimum at the bottom occurs in the beginning of autumn, when the surface attains a maximum."

Last year a new departure in the way of marine temperature observations was inaugurated by Dr. John Murray, namely, the study of the effect of the wind upon the distribution of submarine temperature. For such an inquiry the land-locked fjords of the west coast of Scotland are particularly well adapted; the depth of the lochs in conjunction with the frequent presence of a bar across their mouths renders the change of their contents but slow, while the moderate size of many of them makes it practicable to ascertain the condition of the whole loch as regards temperature at pretty frequent intervals. To give many figures bearing upon an inquiry of this kind would be out of place in a sketch like the present; a brief notice of one or two interesting cases must suffice. On September 7th, 1887, an examination was made of Loch Lochy, the most southerly of the three which lie in the course of the Caledonian Canal, a small body of fresh water nearly ten miles long and about

seventy-five fathoms in its maximum depth. The wind was north-easterly in direction, thus blowing directly down the loch, and its force was 1 or 2 of Beaufort's scale. Under these circumstances a mass of water, extending five-sixths of the distance up the loch, and averaging fifteen fathoms in depth, had a temperature of over 55° F.; below this a stratum of water, varying in thickness from nine fathoms at the south end of the loch to twenty fathoms at the north end, had a temperature of from 50° to 55°, whilst the whole of the water below this was at less than 50°. By September 9th the direction of the wind had changed to west-south-west, and its force had increased to from 5 to 6; it was thus blowing along the loch almost in the contrary direction. It was now found that the water of over 55° occupied the northern two thirds of the loch, extending to a depth of fifteen fathoms at that end of it; below it was a layer of nearly the same average thickness as before of water between 50° and 55°, but it now came to the surface at the southern extremity of the basin, whilst the mass of comparatively cold bottom water remained unchanged.

On the same trip a very similar phenomenon was observed in Loch Ness, a much larger body of water on the same canal. Just before the gale from the south-west set in, water above 53° formed a moderately even layer all over the surface, varying in thickness from fifteen fathoms at the south end of the loch to thirty fathoms at the north. A few hours later it was ascertained that the whole mass of water above this temperature had been blown up the loch so far that the surface water of the southern fifth of it had a temperature of below 53°. In connection with the above, reference may be made to a series of observations carried out on the 25th and 26th April during a south-westerly gale. In this case it appeared that the strong wind had so displaced the normally horizontal position of the strata of water, that the surfaces separating them were almost vertical. Observations having on the whole similar results have been carried out in Loch Striven, Loch Fyne, and other localities.

The advice and assistance of the Scottish Marine Station have been freely placed at the disposal of any bodies which

were engaged in similar work, and the services of Dr. Mill have more than once been secured by the Fishery Board for Scotland, in whose annual reports his work for them will be found recorded.

Biological Investigations.

The biological work of the Scottish Marine Station may naturally be considered under two headings—Morphological and Faunistic. The papers in the former category are nearly all the work of Mr. J. T. Cunningham, who was for a period of more than three years the Superintendent of the Granton Laboratory. During the year 1885, much of his attention was devoted to the study of the development of the herring, for which purpose he not only worked in the Firth of Forth itself, but spent several weeks at the village of North Sunderland on the Northumberland coast. The eggs were collected during nocturnal trips in the herring boats, and kept whilst developing on glass plates in wooden boxes sunk near the shore, so that they could be examined when required. The time of development and the temperature of the water were carefully observed, and it was found that the eggs hatched in eight days when the temperature of the water varied from 11·5° C. to 14·5° C. One obscure structure in the herring embryos received Mr. Cunningham's special attention. This is a small rounded cavity, which is known from its discoverer as Kupffer's vesicle, and which appears at an early stage of development between the posterior end of the embryo and the yolk; it is clearly visible on the third day and remains so for eight or nine hours, but cannot be seen on the fourth day. This cavity appears from careful investigation by means of sections to be the last rudiment of the cavity of invagination, by which the primitive intestine is formed in all except the lowest animals. The theoretical bearing of this and other developmental researches has been discussed by Mr. Cunningham in several papers, which are too technical for abstraction here.

The "glutinous hag" or "sucker" (*Myxine glutinosa*),

a semi-parasitic fish allied to the lamprey, is not uncommon on the east coast, and is a great pest to the fishermen by devouring the cod on the lines or taking the bait from the hooks. It is, however, an object of great interest to zoologists, from its exhibiting several very primitive characters in its organisation, which render a knowledge of its developmental history a great desideratum. It has long been known that the mature egg is contained in a hard, horny husk, at either end of which is a bunch of stiff processes like bristles, but with two or three hooks at the end of each ; hitherto only two such eggs have been found,* and Mr. Cunningham, in spite of numerous efforts and much expenditure of time and money, was unable to obtain more, even by keeping adult animals for months in an aquarium, so he took advantage of the opportunity offered by his having numerous specimens at his disposal to make a careful investigation of the development of the reproductive products, which has led to some interesting results. The horny envelope of the egg appears to correspond to the so-called " zona radiata " of the egg of other fish, that is to say, it is a primary egg-membrane and not an extraneous growth. Male specimens are exceedingly rare, but in the great majority of those in which the eggs are immature the hinder part of the generative gland is a well formed testis ; and Mr. Cunningham is inclined to think that these immature animals are functionally males and that most eggs are fertilised by them.

A department of knowledge in which science is at present very backward, is that which relates to the eggs and young stages of food-fishes ; this inquiry was successfully prosecuted by Mr. Cunningham, and the results of his work, containing not only descriptions and figures of the eggs of about a dozen species, but also an account of previous researches in this direction, have been published by the Royal Society of Edinburgh. At the time of his departure from Granton, Mr. Cunningham was engaged in a systematic and anatomical study of the Annelida of the Firth of Forth, a work which

* Dr. Fridtjof Nansen has just informed me that he has discovered a third egg among the stores of the Bergen Museum, which was dredged thirty years ago by Dr. Danielssen near Molde.

has already yielded fruit in the publication of several papers on this interesting group of animals.

The small crustacean *Nyctiphanes norvegica* is pretty commonly found in the Firth of Clyde in deep water; when alive it is a most graceful creature, swimming rapidly round the aquarium, with the dorsal or ventral surface indifferently uppermost. Its chief interest, however, consists in the possession of luminous organs, which it shares with most, if not all, the Euphausiidæ. The fact that certain Schizopod Crustacea have the power of emitting light appears to have been first noticed by Vaughan Thompson,* and the organs in question were described by Claus† under the name "accessory eyes." The phenomenon was a matter of frequent observation during the "Challenger" expedition,‡ and the phosphorescent apparatus was described as such by Sars,§ in his report on the Schizopoda, both in *Euphausia* and in a new species of *Nyctiphanes* (*N. australis*). He did not, however, enter upon a histological examination of these organs, and with a view of supplying this lacuna in our knowledge Mr. Rupert Vallentin, with the co-operation of Mr. Cunningham, subjected them to a thorough investigation. A large number of specimens were obtained in ninety-five fathoms off Brodick Bay, and conveyed to the "Ark" at Millport for examination. Each animal possesses ten of these organs: one in each eye-peduncle, one in the basal joint of each second and one in the basal joint of each seventh thoracic appendage, while the remaining four are unpaired and situated, one in the lower surface of each of the first four abdominal segments. Each "photosphere" (a name proposed by Messrs. Vallentin and Cunningham for these structures) is a spherical body lying immediately beneath the epidermis, and almost entirely independent of the surrounding tissues. Its posterior half is formed by a stratified, fibrous, non-cellular, hemispherical cup, within which is a layer consisting of large cubical cells internally,

* 'Zoological Researches,' ii, 1829.

† 'Zeitschr. f. wiss. Zool.,' xiii.

‡ 'Narr. Chall. Exp.' I, ii, p. 743.

§ 'Zool. Chall. Exp.,' xxxvii, pp. 70, 119.

and smaller cells externally. The hollow of the hemisphere is filled with a fibrous mass, the constituent fibres of which are perpendicular to the cellular layer outside, but cross each other at right angles at the centre. This is succeeded in front by a homogeneous, highly refractive lens, surrounded by a ring similar in structure to the stratified layer, and without this again is a stratum of cells smaller than those mentioned above. The posterior half of the organ is overlaid by a coating of flat, polygonal, red pigment-cells, which seem to be merely a specialised form of the chromatophores, which are scattered in various parts of the body. A connection with the nervous system, although it almost certainly exists, has not yet been demonstrated. These luminous bodies may be acted on either by mechanical or chemical stimuli, and it was ascertained that the light proceeds from the innermost part of the stratified cup above described, which appears to possess the property of fluorescence in a remarkable degree.

A few months ago an adult whale (*Balænoptera rostrata*) came ashore in the narrow entrance to the quarry, and was speedily killed by the dwellers in the neighbourhood. It was thereafter towed round to Granton Harbour, hoisted on a railway truck, and thus conveyed within the walls of the Marine Station, where it continued to attract crowds of visitors for some time. An anatomical examination of it was undertaken by Sir William Turner and several assistants.

The faunistic work was at first the special province of Mr. J. R. Henderson, until his appointment to a Chair of Biology in Madras deprived the station of an accurate and energetic worker. Before his connection with the Granton station Mr. Henderson had acquired a large private collection illustrating the local marine fauna, and by means of the new facilities at his disposal he was able to make many interesting additions to the fauna of the Firth of Forth. He specially devoted himself, however, to the Crustacea ; and his ' Synopsis of British Paguridæ ' gives an orderly account of a group which had for long been much neglected, whilst his ' Catalogue of the Decapod and Schizopod Crustacea of the Firth of Clyde ' includes twenty-one species which have

been added to the British fauna since the publication of Bell's great work, and five (including a new genus) are recorded for the first time. It contains, also, a list of all the higher Crustacea from the West of Scotland compared with similar lists from Scandinavia and the Mediterranean.

The numerous trawlings and dredgings which have been conducted by Mr. John Murray on the west coast are of great interest. Large collections have been sent to the British Museum, and it is hoped that all the lists prepared by the naturalists of that institution may shortly be published, for they contain records of the occurrence of many interesting forms, some of which have not hitherto been known to inhabit British seas.

The examination of the fishes has been conducted by Dr. Günther, and an interesting report upon them was communicated to the Royal Society of Edinburgh on March 5th of the present year.

Excluding certain common species forty-seven different forms were collected, some of which are of special interest. The Arctic genus *Triglops* is represented by a new species (*T. Murrayi*), whilst *Cottus Lilljeborgii* and *Gadus Esmarkii* are new to the British Fauna. *Callionymus maculatus* was recorded by Dr. Günther in 1867 from the Hebrides, but is now shown to be fairly abundant in Kilbrennan Sound at a depth of twenty-six fathoms.

As might be expected such investigations, carried on for a considerable period, have yielded a mass of information of more or less miscellaneous character which it is impossible to summarise; a few items are selected, for mention here. Some instances of peculiar distribution have been recorded from the lochs of the west coast, which furnish additional proof of the fact demonstrated by the "Porcupine" and "Triton" expeditions,* that submarine barriers have a preponderating influence in the limitation of marine faunistic areas. For instance, *Conchœcia elegans*, a pelagic Ostracode of the deep Norwegian waters, is found nowhere on the Scottish coast except in Upper Loch Etive, at depths of from

* 'Proc. Phil. Soc.' Glasgow, xvii.

thirty to seventy fathoms. The genus *Pasiphæa* occurs in the Mediterranean and off Norway, and has recently been detected in deep water in Loch Etive, Kilbrennan Sound, Lower Loch Fyne, and other localities, but never in Upper Loch Fyne, Loch Long, or Loch Goil. It may be mentioned in passing that *Nephrops* also is never got in Upper Loch Fyne. *Nyctiphanes norvegica* is abundant in Upper Loch Fyne, but has not been found either in Upper Loch Etive or Loch Aber; at the mouth of Loch Sunart a few specimens have been caught, and in Loch Hourn it is abundant. The allied *Boreophausia* is common in Loch Duich. *Euchæta*, a large Copepod, is pretty generally distributed in the Clyde Basin, though it is not found abundantly in Kilbrennan Sound and towards the Mull of Cantyre; farther north it occurs in Loch Etive, but not in Loch Aber, Loch Sunart, or Loch Carron. *Euchæta* and *Nyctiphanes* are never found on the surface in the adult condition, but their larval forms seem from recent tow-nettings to be not uncommon on the surface in the spring. The present writer has within the last few weeks found what appear to be the eggs and the Nauplius and Cyrtopia stages off the coast of Arran, and Mr. George Brook has the Metanauplius and several Furcilia stages from the same district. Dr. Murray further states that these eggs and larvæ have been abundant at the surface all over the Clyde sea area for the past two months.

Most of the forms enumerated above are deep-sea animals, not being found within the 100 fathom line, except in these land-locked fjords, to which perhaps they may have been confined by the gradual rising of the land after the glacial period.

Another observation deserving of mention here is the fact that in the early spring an extensive layer of Diatoms (*Coscinodiscus, &c.*) appears upon the surface of the water and gradually sinks as summer advances. Concurrently with this swarms of larvæ are developed, the examination of whose stomachs proves conclusively that they are nourished by these Algæ whilst they themselves furnish the food of the Loch Fyne herring and other fish, which seem to approach the surface at this period. The

herring itself is said by the fishermen to be subject to a disease known as "poke-gut," which they believe to be due to the fish "eating some black substance which burns through them like quicklime." Dr. Murray has ascertained that this black material is due to the pigmented eyes of Schizopod larvæ, which have been devoured in quantities by the fish and undergone such rapid decomposition that even in a few hours they will penetrate the abdominal wall.

It seems more than doubtful whether the herring migrate, as is commonly supposed, between these deep lochs and the open ocean. It appears more probable from several indications that they winter in the deep water, and come to the shallows for breeding purposes. This would account, amongst other things, for the fact that each district has a recognisable variety of herring peculiar to itself. During the winter months herrings have been captured in depths of forty fathoms with their stomachs distended with adult *Nyctiphanes*, and young herrings have been taken at similar depths throughout the whole year.

After such an account of work, as even this brief record supplies, it seems a work of supererogation to attempt any justification of such an institution as the Scottish Marine Station. Before it is possible to attempt an intelligent regulation of our fisheries, the first requisite is more knowledge, a detailed acquaintance not only with the fish themselves and their habits of life, but also with the physical conditions in which they dwell, and of the life-history and distribution of the organisms which serve as their food. Such an acquaintance with the subject is merely in its infancy at present, and with our best efforts many years must elapse before it can be even approximately adequate to our needs. One Zoological Station, however well equipped, can only explore a limited area, and there is room in this field for many workers, whose results when collected and compared will lead to such generalisations as may render it possible to legislate upon these questions with sure hope of success.

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NOTES AND MEMORANDA.

Some Notes on Plymouth Fishes.

The Habits of the Cuckoo or Boar-fish.—For some time after I arrived in Plymouth at the beginning of August I heard a great deal about "cuckoos." The trawlers were constantly talking of them, saying that their catches consisted almost entirely of them, and it was not long before I saw specimens of the fish which, among the fishermen, went by this avian name. Even before I saw a specimen I found, on referring to Day's 'British Fishes,' that the name implied the *Capros aper* of Lacépède, the boar-fish of Couch. I found specimens, soon after, knocking about the Barbican in numbers, floating about Sutton Pool and Cattewater, or cast up on the shores of these basins. Why the name cuckoo is applied to these fish I have not discovered, but Couch's name is due to a certain peculiarity in its snout. The lower jaw, when the mouth is closed, slants upwards and forwards and projects beyond the upper. When the mouth is opened, and the lower jaw depressed, a system of levers formed by bones at the sides of the mouth is moved and causes the upper jaw to be protruded forwards. The upper jaw is not firmly fixed to the skull, but connected with it by ligaments and membranes which are very elastic. Thus the depression of the lower jaw brings about a remarkable protrusion of the upper, so that the whole mouth, when opened, forms a narrow cylindrical membranous tube an inch or more in length. As soon as the lower jaw is closed the upper jaw is drawn back to its original position by the elasticity of its ligaments. Thus the mouth region of the "cuckoo," when the mouth is open, resembles somewhat the snout of a boar; hence the name boar-fish, and the specific name *aper*. The mechanism of the jaws in the cuckoo is an exaggerated development of an arrangement which occurs in the herring and other fishes, and it will be of great interest

to make an accurate examination of this mechanism of the mouth and carefully compare its condition in *Capros aper* with that found in other species. The protrusion of the jaws is doubtless of some importance in procuring food, but at present we do not know what peculiarity in the feeding of the cuckoo makes such a curious arrangement necessary.

On August 15th, when I went out in the trawler "Cambria" on one of her fishing trips, an enormous number of cuckoos came up in the trawl. The fish is absolutely worthless in the market, and this for two reasons : 1st, it is small, never exceeding seven inches in length, and 2nd, it is very thin and very bony, the bones of the head and the spines of the fins being extremely well developed. It is easy to understand, therefore, the feelings the trawler has for this fish when he has to haul up several hundredweight of it in his trawl and then throw it overboard again. I had ascertained previously, from information given me by the fishermen, and from examination of specimens picked up in the harbour, that the cuckoos were sexually ripe, and in the process of spawning. I therefore examined those which came up in the trawl of the "Cambria" with interest, and found, as I expected, that it was easy to squeeze ripe ova and milt from the fish. I obtained thus a sample of the fertilized ova in a bottle of sea-water, which I was able to carry ashore successfully. The ova were transparent and buoyant like those of so many other fishes, and of small size. I kept the ova alive two days on shore, and examined them with the microscope, making drawings which are reserved until material for a comprehensive account of the ova of the Plymouth fishes has been collected. The ova measures ·98 mm. in diameter, varying slightly from this standard. The yolk is perfectly transparent and homogeneous, and contains a single oil globule, which is near the surface of the yolk at the side opposite the embryo. I had a drawing of a pelagic ovum obtained by the tow-net in Whitsand Bay on August 11th, and found it was exactly similar in size and structure to the ovum of the "cuckoo." It was evident, in fact, that it belonged to that fish.

Specimens of the "cuckoo" had been found to contain

spawn by different observers in March and May, and in the Mediterranean in April. But no one had given an account of the character of the fertilized ova until Mr. Dunn stated that in July, 1880, many of these fish had spawned in his tank, and that the spawn floated in the water just below the surface. He did not keep the ova under observation, or give any description of their structure. There is only one other species of the family to which the "cuckoo" belongs (Carangidæ), whose ova have been described, namely, *Temnodon saltator*, Linn., the bluefish of the Atlantic shore of the United States. The ova of the bluefish are pelagic and transparent like those of the cuckoo, but they possess certain peculiarities not present in the latter.

Although the cuckoo is worthless in the market it is indirectly of economical importance, to judge from the fact that I found a specimen slightly digested in the stomach of a large turbot brought up in the trawl of the "Cambria."

Fishermen at Plymouth say that the great abundance of cuckoos in their neighbourhood is a somewhat recent phenomenon, and that they were scarce or unknown twenty years ago. As a matter of fact the first recorded capture on the British coasts took place in Mount's Bay in October, 1825. In 1843 a great abundance of them is recorded to have occurred at Plymouth, and the fishermen then stated that they had recently increased in numbers so as to become a pest. It is thus probable that, as with other fish, they may in one locality become more and more numerous for some years and then again become scarce. They are taken only in very small numbers in the winter, and it is evident that they approach the shore for the purpose of spawning in the season from May till October, but they are most abundant at Plymouth in July and August when spawning actually takes place.

The Breeding of the Conger.—Often when fishermen are asked at what time of the year a certain fish spawns they give a definite answer which is correct or approximately so. They can see the ripe roe in most kinds of fish when a specimen is cut open, and they can see the distension of the abdomen caused by the enlarged roe, while frequently the eggs flow

from the ripe fish when it is handled. But whenever I have inquired as to the spawning of the conger the answer I have received from fishermen is that nobody knows, and that no one ever saw a roe in a conger at all. A naturalist who is acquainted with the obscurity which for two centuries, in spite of earnest investigations, concealed the structure and functions of the generative organs of the eel family, cannot wonder at the confessed ignorance of the fishermen on the subject. No one has yet, I believe, seen the fertilized egg of either the eel or the conger, although the ovaries and testes have been recognised and described. When I took some conger and examined the internal organs I found no difficulty in recognising the roe or ovary. In a large specimen, four to five feet long, the ovary is seen as a broad white mass in the shape of a ribbon, running on each side along the body cavity; on the side towards the intestine the ribbon is smooth, but on the other side it bears a number of thin flat plates, attached to it transversely, and lying close to one another face to face like the leaves of a book. Each of these leaves is made up almost entirely of eggs, which are supported by a tissue consisting apparently of fat-cells. When this ovary is shown to a fisherman he says it is simply the fat of the fish, and evidently does not believe it has anything to do with spawn. The organ is of milky-white colour, and resembles fat closely in appearance, but the microscope reveals the eggs in it beyond all possibility of mistake; and lately, in a specimen four feet ten inches long, the separate eggs could be seen in every part of the ovary with the naked eye like grains of millet seed. There must be over a million eggs in each ovary, indeed, the number of ova has been calculated by different observers to reach several millions. Otto Hermes in Berlin estimated 3,300,000 in a pair of ovaries weighing twenty-two and a half pounds, while Mr. Jackson, at the Southport Aquarium, estimated over 6,300,000 eggs in a pair of ovaries weighing only seven pounds. Mr. Jackson's specimen died in June, and if its ovaries were ripe and ready for spawning, as we may presume they were, then we may conclude that it is probably in June that congers naturally spawn. Neverthe-

less, the condition of the last ovary I examined (on November 3rd) leads me to believe that spawning takes place earlier in the year, at all events off Plymouth.

A single specimen of the male conger was discovered by Otto Hermes ('Zool. Anz.,' 1881). It died in the Berlin Aquarium in June, 1880; it was two feet six inches long, and the testes were similar in position to the ovaries, but differed from these in being divided into lobes, and entirely surrounded by a smooth membrane, the seminal fluid passing to the exterior by a special efferent duct. The organs were ripe and contained mature, actively moving spermatozoa. I have opened altogether fifteen congers. Seven of these were chosen on account of their small size, two feet four inches to two feet ten inches in length; but every one of the fifteen was a female, and as yet I have not seen the male.

The Spawn of the Pilchard.—Up to the present I have not met with any pilchards in a sexually mature condition. Nearly all the available information concerning the breeding of this species is directly or indirectly derived from accounts of his own observations published by Mr. Dunn, of Mevagissey. One of these accounts is contained in the official report of Frank Buckland and Spencer Walpole on the British Fisheries, 1879, App. iii. It is there stated that pilchards spawn fifteen or twenty miles from land, and at or near the surface; that on May 28th, 1871, Mr. Dunn took a pilchard in the act of spawning twenty miles from land, and pressed out its spawn into a bucket of sea-water, when the eggs all floated separately at the top of the water, but died after two hours because they were unfertilised; when dead they sank to the bottom. But in a letter which Mr. Dunn kindly sent me recently in answer to some questions I put to him, he says that he is certain that some pilchards spawn late in December and early in January, because he has known shotten pilchards return to the bays as early as the 11th of January. It is thus possible enough that the pilchard has two principal spawning seasons on this coast, one in winter, in December and January, one in June and July, in summer. It is also possible that some of the fish may spawn somewhat earlier, and others somewhat later than

the months mentioned. On November 9th, in the product of a tow-net taken by me south-east of the Eddystone, there were a number of buoyant fish eggs, which hatched two days after in my workroom on shore. The young fish hatched from these exhibited three characters, which are also found in the newly-hatched herring: (1) The yolk, instead of being homogeneous as in most buoyant ova, was composed of a number of distinct yolk-spherules; (2) The notochord was unicolumnar, that is, contained a single linear series of vacuoles as in the herring, not several series side by side as in young flat-fishes and others; (3) The anus was separated by a long interval from the yolk, and placed near the end of the tail, as it is in the newly-hatched herring, while in most fishes it is immediately behind the yolk. It is possible enough that these buoyant eggs are those of the pilchard, in which case the close similarity of the fish hatched from them to the young herring would be explained, although the proof of the fact that the ova of the pilchard are typically buoyant and pelagic, while those of the herring are typically adherent ova, would be very surprising. I earnestly hope that during the present winter I may obtain some pilchards in spawning condition, in which case, by taking and fertilizing some ova, I should be able to decide the interesting questions implied in the above discussion. There are some grounds for saying that it is possible the ova of the sprat are buoyant, although it would be naturally expected that all the species of Clupea deposited adhesive eggs like those of the herring.

Reproductive Organs of the common Sole.—On November 12th I dissected four soles (*Solea vulgaris*, Quensel) in order to examine the reproductive organs. The soles were bought by the Laboratory attendant from a fish buyer, and therefore could not well have been selected in any way, except that they were all moderately large. Two were males and two females.

In one female, which was fourteen inches long, including the tail, I opened first the long posterior extension of the body cavity on the right, dark, and upper side. When the skin was laid open, without further dissection, four parallel

lengths of intestine were seen extending right to the posterior termination of the cavity. Beneath these, but partially exposed at the ventral edge of the cavity, was the right ovary, which was four and a half inches long, three quarters of an inch broad. It was yellow in colour, and almost mature, the ova being visible to the unaided eye as separate granules. The ovary did not reach posteriorly to the end of the cavity by about an inch. Anteriorly it did not extend into the undivided anterior portion of the body cavity, the oviduct, which was about three quarters of an inch long, passing forwards and ventrally to the genital opening.

The cavity of the left side was then opened. In it there was no portion of the intestines; it contained the left ovary, which was five inches long and half an inch broad, longer and narrower than the right. At the anterior end of the cavity was seen the left kidney, a large portion of which lies in this posterior extension of the body cavity. In the undivided portion of the body cavity on the left side is seen nothing but the left surface of the liver. The two posterior extensions of the body cavity are, of course, completely divided by a thick median partition containing the interspinous bones belonging to the anal fin.

In a male which was fifteen and a half inches long, including the tail, on opening the posterior extension of the body cavity on the right side, the same four lengths of intestine was seen, and no genital organ was visible while these were undisturbed. The testis was found beneath these intestines, at the anterior end of the cavity. It was a flat plate with an entire outline lying on the partition which separates the right posterior cavity from the left. It did not extend in front of this partition into the undivided body cavity, its vas deferens passing forwards and ventrally to the genital opening. The testis was one inch long and half an inch broad. On the left side the posterior body cavity was short, only about half the length of the corresponding cavity on the right. It contained no organs except the left kidney which extends back into it. The left testis was smaller than the right, being three quarters of an inch in length; it lay with its longer axis transverse to the axis of the cavity,

i. e. in a position at right angles to that of the right testis ; and it was in front of the anterior edge of the partition between the two posterior cavities, so that its duct passed ventrally to the genital opening.

I believe that the male can always be distinguished by the narrower shape of its posterior region. The presence of the roe in the female causes the ventral edge to have a more convex outline in the female, but the dorsal edge also is much less slanting and more convex in the female than in the male. The tail in the male is also, in the specimens I have examined, larger than in the female.

The sole spawns in winter and spring, as stated in the books, and it is evident, from the condition of the specimens I have described, that they were near the spawning period.

J. T. Cunningham.

February 29th, 1888.

NOTICES.

At a Council Meeting, held on July 25th, 1888, the regulations with regard to the admission of Naturalists desiring to make use of the Plymouth Laboratory were amended and enlarged as follows :

1. Any Governor or Founder of the Association is entitled to occupy *in propriâ personâ* a table at the Plymouth Laboratory without payment. A Founder or Governor shall have the privilege, upon signifying to the Director his intention to forego permanently the right of personally occupying a table in the Laboratory, of nominating an eligible person to make use of a table for one month in each year free of charge.

2. The charge for a table shall be £40 a year, £25 for a half year, and £5 for a month, to be paid in advance. No table shall be let for less than a month, and the monthly charge shall be as above for any number of months less than six.

3. Members of the Association have the first claim to become renters of tables.

4. Life Members of the Association are entitled to occupy *in propriâ personâ* a table at a reduction of one fourth from the above rates.

5. The Council of the Association may remit, in whole or in part, the payment of rent for a table in special cases. No charge will be made to a State-recognised authority for the use of a table.

6. Applications from Members and others desiring to occupy tables must be made in writing to the Director, and a notice of at least seven days will be expected before any table is ready for use.

7. The Association undertakes, so far as possible, to supply the material required for any investigation, and such facilities for obtaining it as may be at the command of the Association.

8. The Association supplies to the occupant of each table

ordinary glass jars, dissecting dishes, bottles, pans, &c., not to be removed from the Laboratory, also the ordinary chemical reagents, and ordinary methylated alcohol to the amount of two gallons per month. Absolute alcohol will be supplied to the extent of half a pound per month. Each Naturalist must pay far what he requires in excess of these amounts. The Association does not supply microscopes or other instruments. The more expensive reagents, as well as glass slips and covers and other portable apparatus, may be purchased of the attendant. Each Naturalist will be provided on arrival with a list of the free equipment supplied by the Association.

9. For the purpose of enabling the Director to draw up the half-yearly statement of the work of the Laboratory required by H.M. Government, and for the information of the Association, all Naturalists working in the Laboratory, at the completion of their work, or if not completed after three months then at intervals of three months, are expected to furnish the Director with a summary statement of the investigations carried on by them in a form suitable for publication in the Journal of the Association.

10. No Naturalist can be permitted to make zoological collections in the Laboratory. The Association undertakes to provide collections of marine animals, and to supply them at a fixed price to those who wish to buy them. This rule must be understood to apply only to general zoological collections. Every Naturalist is at liberty to collect and take away with him any material that is necessary for the prosecution of his special line of research on payment of the cost of bottles and packing cases necessary for their removal.

11. The animals collected by the fisherman will be delivered to the Superintendent of the Laboratory, and distributed by him. The fisherman of the Association is prohibited from delivering specimens directly to the Naturalists.

12. Naturalists who are desirous of making use of the boats of the Association must apply to the Director for permission to do so.

13. A portion of the tank apparatus in the main Laboratory will be allotted to each Naturalist. Applications for small aquaria, glass vessels, caoutchouc and glass tubing must be

made to the Laboratory Superintendent. Naturalists are not permitted to overcrowd the aquaria or contaminate the sea water in circulation.

14. There will be a collection of named specimens which may be used for reference and identification. Any Naturalist desiring to use the named specimens will be supplied with them on application to the Director. He will be required to return the specimens uninjured as soon as he has done with them.

15. Naturalists working in the Laboratory will have free access to the tankroom at any hour of the day, but they are not permitted to have access to the interior of the tanks without the permission of the Director. Facilities for conducting experiments on a large scale will be granted as far as space permits, but each Naturalist will be held responsible for the consequences of such experiments.

16. Any member of the Association is at liberty to view the Laboratory and tanks between the hours of 10 a.m. and 6 p.m. on presenting his card to the Director.

17. The Director has control of the Laboratory boats and apparatus of the Association. Persons are admitted as renters of tables solely on the condition that they accept this control, and agree to abide by the regulations drawn up by the Council of the Association.

Mr. Robert Bayly, of Torr Grove, Plymouth, has given a further donation of £500 to the Marine Biological Association, which sum is to be spent on an investigation on the means of improving the supply of bait for long-line fishermen. The Council having instructed the Resident Director to make a report on the best method of applying this sum to the purpose, he will be glad to receive any suggestions addressed to him at the Laboratory, Citadel Hill, Plymouth.

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